THE UNIVERSITY OF ALBERTA

THE IMPACT OF PHONOLOGICAL ENVIRONMENT UPON AUDITORY DISCRIMINATION OF WORD-PAIRS AND ITS RELATION TO BEGINNING READING

by

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DISSERTATION ABSTRACT

In the initial stages of learning to read it is important for a child to be able to indicate that he can hear a sound and to distinguish slight differences between similar speech sounds embedded in words. Results of recent research studies appear to be opposite to expectations, as stop and nasal sounds, which are articulated correctly at an early age before such sounds as glides and laterals, were not discriminated accurately at age seven by many children when auditory discrimination of glide and lateral sounds was accurate. It was the primary purpose of this study to investigate the impact that phonemic elements of stop and nasal sounds have upon auditory discrimination, to ascertain a developmental pattern that might exist in the ability of Kindergarten and Grade One children to discriminate auditorily stop and nasal sounds and to determine the relationship of auditory discrimination to beginning reading.

To investigate the ease or difficulty of perception of particular sequences of phonemes and their relation to other auditory abilities, as well as the importance of maturation and learning to their development an auditory discrimination test was constructed. The results of the initial form of the auditory discrimination test administered during the Pilot Study were subjected to a Test Item Analysis computer program. The revised form of the research instrument, the <u>S-N Auditory Discrimination Test</u> was used to assess the auditory discrimination ability of subjects in the main study.

Auditory acuity, auditory discrimination and auditory memory span tests were administered individually to a sample of 100 subjects

during their final month in Kindergarten and six months later in Grade One. Standardized tests of mental maturity and oral and silent reading were administered to the subjects in Grade One. Information concerning the linguistic aspects of the home environment of the child and other pertinent data were obtained from cumulative record cards in the school. Data collected were analyzed by means of computation of correlations, t-tests of differences between means and analysis of variance.

The investigation revealed that prior to initial reading achievement, children developed an ability to discriminate auditorily finer differentiations of stops and nasal sounds within specific phonemic environments. While the environment of stop and nasal sounds facilitated auditory discrimination of these sounds, it also appeared that children progressed through various levels or stages in auditory discrimination ability not only in general but with respect to specific sound sequences. Results of this study, while revealing the interrelatedness of features of sounds, suggested a spiral effect operating in the ability of Grade One children to discriminate stop and nasal sound contrasts.

Results of the study also showed a general increase in auditory acuity, auditory discrimination and auditory memory span ability of children from Kindergarten to the third month of Grade One. Furthermore, results of the study uphold that ability of children to discriminate and recall sequences of sounds is related to initial reading achievement.

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INTRODUCTION AND STATEMENT OF THE PROBLEM

Reading means many things to many people, but the one element common perhaps to all people is the recognition of the importance of reading for living in a changing society. How does a child learn to read? How can the child be taught to read? The importance of these unanswered perennial questions can be attested to by the vast amount of research devoted to identifying and investigating factors believed to be associated with success and failure in reading.

In the initial stages of learning to read, it is important for a child to be able to indicate that he can hear a sound and to distinguish slight differences between similar speech sounds embedded in words. The ability to distinguish slight differences between similar speech sounds may pose a problem for some children entering school. This is understandable, for words, at this time in the language development of the child, are just part of a total pattern of meaning. In spoken language, words, usually surrounded by circumstantial cues, are almost always embedded in context, while in initial reading each word, for the most part, must be recognized independently by a child before he proceeds to the next word. That is, a child, whose oral language is spontaneous and fluent, who has developed a wide speaking vocabulary with clear enunciation, may not realize that spoken language consists of sequences of separate words, and may be unaware of the

sequences of phonemes used in the production of these words. As a result, it is possible that such a child may have difficulty in associating phonemes with graphemes or sequences of graphemes in the early stages of learning to read.

There are two distinct stages specific to the early reading process, the initial stage consisting of the first step in decoding, recoding orthography into previously learned speech patterns, and the second stage consisting of abstracting meaning from the printed page while emphasizing the importance of complete and accurate perception. The reading act, to be complete, is dependent upon both processes; the second, the obtaining of meaning, cannot be obtained without the first, the identifying of the symbol. Therefore, in the beginning stages of learning to read, stress should be placed on the perceptual level, otherwise later learning at the conceptual level may be impeded without the necessary fundamental structure on which to build and to develop the ultimate goals of reading.

As a child must associate phonemes with graphemes in reading, certain refined perceptions must be made in the auditory realm. The young child, to be successful in reading, should be able to receive phonemes clearly, to differentiate and isolate phonemes, to retain and to recall them accurately in sequence, and to organize them into linguistic symbols.

Recent auditory studies have not been conclusive but they indicate that auditory abilities are developmental and do not reach fruition in some children until the ninth year. More recently, research studies have attempted to determine the type of sounds children discriminate incorrectly. Results of these studies (Cosens, 1968;

Oberg, 1970) appear to be opposite to expectations, as the stop and nasal sounds, while articulated correctly at an early age before such sounds as glides and laterals, were not discriminated accurately at age seven by many children when auditory discrimination of glide and lateral sounds was accurate. If it is true that children beginning school are experiencing difficulty in discriminating stop and nasal sounds, it would follow that these same children would have difficulty with beginning reading, as they would have trouble in associating a stop and nasal sound with the accepted printed symbol. The recognition of the importance of the findings of recent auditory discrimination studies to beginning reading, and the difficulty that children may experience in learning to read, as well as the recognition of the task that the teachers of the primary grades encounter in meeting each child's needs, led to the present study.

I. PURPOSE OF THE STUDY

The primary purpose of this study was to investigate the impact that phonemic elements of stop and nasal sounds have upon auditory discrimination, to ascertain a developmental pattern that might exist in the ability of Kindergarten and Grade One children to discriminate auditorily stop and nasal sounds and to determine the relationship of auditory discrimination to beginning reading. By means of an auditory discrimination test constructed by the investigator, information was sought to determine what effect a simple vowel sound has on the discriminability of stop and nasal sounds with respect to place of articulation, manner of articulation, duration and placement of the stops and nasals within the syllabic unit; and what effect auditory

discrimination ability has on reading performance of Grade One subjects.

The study also sought to investigate the relationship between auditory discrimination and auditory variables of acuity and memory span; to determine whether there is a difference between the performance of Kindergarten children on tasks of auditory discrimination, auditory acuity and auditory memory span and the performance of these same children six months later in Grade One on the same auditory tasks; and to ascertain the relationship of the independent variables of chronological age, sex, language environment and intelligence with auditory discrimination as well as with reading achievement.

II. DEFINITION OF TERMS

For the purposes of this study the meaning attached to certain terms is as follows:

Auditory abilities in this study include auditory acuity, auditory discrimination and auditory memory.

Auditory acuity is defined as the ability to hear sound as tested by the use of a pure tone audiometer.

Auditory discrimination is the ability to discriminate fine differentiations of stop and nasal sounds within minimal word-pair items.

Auditory memory span is the ability to reproduce after one presentation a sequence of discrete stimuli in their original order.

Memory letter span refers to the number of letters within the last test item on the *Auditory Memory for Letters Test* which an individual could correctly reproduce after one presentation.

Memory syllable span refers to the number of syllables within the last test item on the Auditory Memory Span for Syllables Test which an individual could correctly reproduce after one presentation.

Chronological Age (C.A.) refers to the age determined from date of birth in months.

Decoding refers to the process whereby graphemes associated with phonemes are changed into previously learned speech patterns and interpreted with meaning.

Developmental for the purpose of this study refers to changes in the ability of Kindergarten and Grade One subjects to make auditory discriminations between speech sounds in a specific phonemic environment.

Grade One high discriminators refers to subjects in the study who attained auditory discrimination scores above the Grade One auditory discrimination mean score.

Grade One low discriminators refers to subjects in the study who failed to attain auditory discrimination scores above the Grade One auditory discrimination mean score.

Kindergarten high discriminators refers to subjects in the study who attained auditory discrimination scores above the Kindergarten auditory discrimination mean score.

Kindergarten low discriminators refers to subjects in the study who failed to attain auditory discrimination scores above the Kindergarten auditory discrimination mean score.

Intelligence Quotient (I.Q.) refers to the current functioning level of intelligence as determined by the California Short-Form Test of Mental Maturity.

Mental Age (M.A.) refers to the measurement of the mental capacity of an individual in terms of the average, chronological age of children showing the same mental standard as measured by a scale of mental tests.

Recoding can take the form of assigning phonemic values to letters, patterns of letters or written word shapes (Goodman, 1965:16). In this study recoding is considered as the first step in the process of decoding.

SNADT refers to the research instrument, the S-N Auditory Discrimination Test. The letters "S" and "N" are substitutions for the words "stop" and "nasal".

III. LINGUISTIC TERMS

In addition to the preceding definitions, the following definitions are used in reference to linguistic terms.

Alveolar is a speech sound articulated by the tip or blade of the tongue against the teeth ridge. Alveolar sounds in this study are /t,d,n/.

Bilabial is a speech sound produced by closing the two lips with or without the addition of voicing. Bilabial sounds in this study are /p,b,m/.

Consonant groupings refer to consonants grouped according to three places of articulation in the mouth. Front - /p,b,m/; Middle - /t,d,n/; Back - /k,g,ŋ/.

Nasals are the sounds which are produced by forcing air through the nasal cavity. The nasal sounds of English are /m,n,ŋ/.

Phoneme refers to a family of sounds in a given language which

are related in character and are used in such a way that no one member ever occurs in a word in the same phonetic context as any other member (Jones, 1967:10). A phoneme is the smallest unit of speech which signals a change in meaning.

Phonemic environment in this study refers to the position of a consonant and a vowel in a syllabic unit and the relationship of their linguistic features to one another in determining the auditory discrimination of a phoneme.

Phonology is the branch of descriptive linguistics which deals with phonemes and sequences of phonemes (Gleason, 1961:11).

Simple Vowel refers in this study to the "pure" vowel as defined by Jones (1957:63). The simple vowel is used to designate a vowel during which the organs of speech remain approximately stationary, as the /ɔ/ in the word "con", in contra-distinction to a diphthong, as the /ɔi/ in "coin", and a consonant, during which the organs of speech perform a clearly perceptible movement.

Stops are consonant sounds in which the flow of air is stopped or obstructed at the point of primary articulation. The stops include /b,d,g/ and /p,t,k/.

Syllabic Unit in this study refers to a sequence of phonemes in a specified order of consonant-vowel or vowel-consonant.

Velar is a speech sound made with the back of the tongue against or approaching the soft palate or velum. The velar sounds used in this study are /k,g,ŋ/.

Voiced refers to speech sounds produced while the vocal cords are vibrating. The nasals /m/, /n/ and /ŋ/, and the stops /b/, /d/ and /g/ are voiced.

<u>Voiceless</u> refers to speech sounds produced while the vocal cords do not vibrate. The stops /p/, /t/ and /k/ are voiceless.

<u>Vowel</u> refers to a sound produced with vibrations of the vocal cords by an unobstructed passage of air through the oral cavity and not constricted enough to cause audible friction. In relation to the vowel, the following independent articulatory movements are considered: (1) tongue height, with three positions in relation to the oral cavity, called high, mid and low; (2) tongue position named front, closest to the lips and moving backward, central and back; (3) the relative duration of the vowel produced.

IV. QUESTIONS

In view of the primary purposes of this research study, the following general questions were explored in order to examine features of sounds which might influence discrimination of stop and nasal sounds contained in minimal word-pair items on the <u>S-N Auditory Discrimination Test</u>.

1. Does the phonemic environment of stop and nasal sounds facilitate the auditory discrimination of these sounds?

2. Does a developmental pattern exist in the ability of Kindergarten and Grade One children to discriminate stop and nasal sounds?

The other major purpose of the study concerning the relationship between auditory discrimination and reading achievement was analyzed statistically and is revealed in the fifth hypothesis listed below.

V. HYPOTHESES

To investigate the remaining purposes of this study, the following null hypotheses were formulated:

1. There is no significant difference between the ability of Kindergarten children to make auditory speech discriminations as indicated by their total test scores on the S-N Auditory Discrimination Test and auditory discrimination ability of these same children when tested six months later in Grade One.

2. There is no significant difference between the auditory acuity of Kindergarten children as measured by the Maico F1 audiometer and the acuity of these same children when tested six months later in Grade One.

3. There is no significant difference between the auditory memory spans of Kindergarten children and the auditory memory spans of these same children when tested six months later in Grade One as indicated by

   a. total memory span score

   b. subtest scores measuring

      (1) memory for letters forward

      (2) memory for letters backward

      (3) memory for syllables

4. There is no significant relationship between auditory discrimination ability of children and

   a. chronological age

   b. sex

c. position in family

d. number of siblings in family

e. language environment in the home

f. auditory acuity

g. auditory memory span

h. intelligence

5. There is no significant relationship between reading achievement and

a. chronological age

b. sex

c. auditory acuity

d. auditory discrimination

e. auditory memory span

f. intelligence

g. mental age

6. High and low auditory discriminators in Kindergarten do not differ significantly in reading achievement in Grade One.

7. High and low auditory discriminators in the third month of Grade One do not differ significantly in reading achievement in Grade One.

VI. LIMITATIONS OF THE STUDY

The major limitation of the study resides in the research instrument, the S-N Auditory Discrimination Test. The investigator recognizes the difficulty in constructing a test to assess auditory discrimination without contaminating the test by making demands on other processes, particularly auditory set and attention and auditory memory.

As the S-N Auditory Discrimination Test is long and contains minimal word-pair items, it is possible that demands were made on the ability of the child to maintain attention for the required length of time, and on the ability of the child with a memory span of less than two to retain and accurately recall a test item in order to compare the minimal word-pair item for likenesses or differences. The investigator recognizes that demands were also placed on the auditory ability of the child with respect to the oral presentation of other tests in the study and the length of testing sessions.

Furthermore, as the auditory discrimination test was limited to stop and nasal sounds in the environment of determined vowels, there were some sounds of the English language not tested in a specific phonemic environment.

The administration of the S-N Auditory Discrimination Test was similar to that of the Wepman Auditory Discrimination Test. All children were given the same instructions and were required to respond to the auditory discrimination task by indicating whether the sounds were the same or different. No attempt was made to differentiate instructions in the administration of the test or to examine responses elicited through differentiation of tasks.

The fact that the tests of auditory discrimination and auditory memory span for letters devised for this study were new and were being used for the first time may also be a limiting factor. In addition, performance on the auditory memory span letter test was limited to children within a narrow age range. Therefore, actual proof of reliability and validity of the memory span letter test will have to be established in further research studies using a wider sampling of

children at different age levels.

Another limitation of the study is that no attempt was made to investigate and to take into account the effect of auditory discrimination training programs being conducted in the classrooms of the subjects in the study.

VII. SIGNIFICANCE OF THE STUDY

It is believed that significant changes in beginning reading instruction cannot come about until educators are fully aware of the need for frequent assessment of auditory abilities of children during their early school years, and of the importance of auditory perceptual development in the initial stages of learning to read. The primary significance of this study is the possible insights which may be revealed concerning fine developmental aspects of auditory discrimination ability in young children during their first months in Grade One, and the effect that auditory discrimination ability has on initial reading achievement.

More specifically, if it is possible to ascertain a developmental pattern in the ability of Kindergarten and Grade One subjects to discriminate auditorily stop and nasal sounds in specified phonemic environments, the study may provide insights in formulating detailed developmental auditory discrimination programs which could influence teaching practices and methods. The study would then provide teachers with information which would be beneficial in aiding young children to develop auditory ability in discriminating the fine differentiations in stop and nasal sounds usually required in first grade reading programs. The study may then be of help in determining beginning reading

procedures for word recognition programs in the lower grades, particularly for children having difficulty in discriminating speech sounds.

VIII. PLAN OF THE INVESTIGATION

The following format was used in reporting the investigation.

Chapter 2 contains a review of the related literature that provided the background for the present study and the basis for the construction of the theoretical model.

Chapter 3 summarizes the theoretical background of the research instrument and reports the construction, administration and revision of the S-N Auditory Discrimination Test.

Chapter 4 describes the design of the study, the nature of the tests administered, the statistical procedures and the characteristics of the sample.

Chapter 5 reports the performance of the test sample on the S-N Auditory Discrimination Test and presents the phonological findings of the study, while Chapter 6 examines the statistical analysis of the data and presents the findings of the study concerning the relationships between auditory discrimination, reading achievement and other factors.

The last chapter, Chapter 7, summarizes the study, and presents the conclusions, and implications and suggestions for further research.

CHAPTER 2

THEORETICAL BACKGROUND AND RELATED STUDIES

The purpose of this chapter is to provide a background for the investigation of the relationship between young children's ability to discriminate between selected speech sounds and their ability to learn to read. The chapter is designed to review pertinent literature concerning the interrelationships of hearing and speech to beginning reading. Studies discussed will not only be related to auditory perception with respect to the three broad categories of auditory acuity, auditory discrimination and auditory memory, but will also be concerned with the phonology and the production of speech sounds. In reviewing the literature pertaining to the auditory perception and production of speech sounds, consideration will be given to the related variables of growth and development, intelligence, sex and socio-economic status. Furthermore, research findings which have made a contribution to what is already known about the relationship of auditory perception to speech production and to reading will also be discussed. These research studies will be reviewed in light of the fact that reading is a facet of language and as such is dependent upon the child's ability to perceive and to produce speech sounds.

I. DEFINITION OF HEARING

For many the term "hearing" is not always completely

understood. Hardy (1960), a well-known audiologist, gives the following explanation as cited by Wepman (1961:245).

> In the course of normal development children learn to understand, to put together meaningful references with the use of verbal-language symbols and then to talk. Hearing does not consist of a built-in set of reflexes, this is only an alerting response. Rather hearing is an appropriate response to an effective stimulus and what is appropriate is largely a matter of the development of the child. This means that an appropriate response to sound particularly to speech sounds is a function of experience coupled with memory and learning.

Too little attention has been given to the fact that the different facets of hearing come to maturity at different rates and thereby limit the ability to learn aurally during the first three years of school. Not only do auditory acuity, comprehension, discrimination and retention develop sequentially on three levels, but they also develop sequentially within these levels, each at its own rate of development with strong interrelationships in maturation (Wepman, 1961:245). From research studies related to auditory perception it is understood that:

(1) there is a consistent increase in sound discrimination ability with age;

(2) children vary in the rate of development of both auditory discrimination and auditory memory;

(3) the development of auditory discrimination and auditory memory has not reached fruition in some children until the ninth year;

(4) the auditory measures are not in themselves predictors of success or failure in reading (Morency, 1968:17).

Basic to the abilities of discrimination and memory already mentioned is auditory acuity. Auditory acuity may be defined as the ability of the ear to collect sounds from the environment and transmit them to the nervous system. If interrelationships among the

auditory abilities could be established, acuity, the most commonly recognized of the three, would be at the base of the triangle (Poling, 1968:8).

II. AUDITORY ACUITY

In summarizing the importance of auditory acuity to academic learning, Howes (1936:38) stated that a relatively small amount of hearing loss, if undiscovered, might become as serious a handicap to education attainment as congenital total loss. Howes' study also revealed that the totally deafened child is detected within the first year of school but the partially deafened child may not be detected until the fourth year. Robinson (1946) inferred that if Howes' findings are indicative of the importance of hearing losses to academic success then auditory acuity would appear to be an important factor in reading failures. Research findings, however, do not seem to substantiate the fact that a child with poor auditory acuity is necessarily a poor reader. As a result of their summation of research findings, Witty and Kopel (1938) concluded that auditory factors appeared to be related to reading only in individual cases where the defect was great or under special conditions. Therefore, the question is raised as to why some children succeed while others fail. Although present terminology may be different or more specific, Gray, as early as 1922, recognized the effect of auditory limitations on reading, and attempted to provide compensatory measures for some children, stating that some pupils who are unable to hear should be taught by different methods, and suggesting special seating arrangements for children who hear indistinctly.

Types of Hearing Impairments

Two types of hearing impairments, namely, conductive impairments and perceptive impairments have been noted by audiologists (Berry, 1956:448, and Newby, 1964:31). Conductive losses which involve a dysfunction of the outer or middle ear are indicated on an audiogram by losses in the low and middle frequency ranges. These losses are amenable to correction by use of a hearing aid. Perceptive impairments on the other hand, which involve degeneration of cells, are indicated on the audiogram by losses in the high frequencies and are not favorable to satisfactory use of a hearing aid. The magnitude of the problem of a child suffering from a perceptive loss in the high frequencies is emphasized by the fact that suppression of sounds in the speech range above 1000 cycles leaves speech only 40 per cent intelligible to listeners with normal hearing. Suppression of sounds below 1000 cycles does minimal harm, as the listener has an accuracy score of 85 per cent (Fletcher, 1953:86).

From the findings of Kennedy (1942) and Henry (1947), Poling (1968) noted a relationship between auditory impairment and socio-economic status. As Kennedy (1942) noted a preponderance of high-frequency losses among pupils of high socio-economic status, and Henry (1947) found children of poor economic status to have more middle tone losses and more general loss than children from better homes, Poling (1968) concluded that high-tone losses which are not readily amenable to medical treatment would be found at both the upper and lower socio-economic levels and low and middle tone losses, which are amenable to adequate medical care, would rarely occur at upper income levels.

Although Poling's conclusion is probable, in the light of

common sense knowledge, other variables must also be considered with reference to the cross-sectional investigation of auditory acuity. One apparent discrepancy is lack of commonality among researchers in determining cut-off points for low, middle and high frequency ranges. As a result, research findings cannot be compared and therefore to some extent they are inconclusive. However, in view of research indicating a higher level of performance in older children, conclusions perhaps would be different if longitudinal studies were conducted with the same students. Furthermore, it is possible that Kennedy's findings (1942) may have been affected not only by the high-economic status of the group, but also by the high scholastic ability of the lab school sample. There appears to be great disparity not only in these early research studies, but also in those conducted within the last decade (Eagles, 1961; Reid, 1962; and Eagan, 1970).

While incidences, ranging from approximately 3 per cent to 35 per cent, of all degrees of hearing impairment are indicated in school populations, the great disparity among the reports seems to be due to the lack of uniformity in methods of testing, in techniques of measurement and in standards in reporting hearing loss. Kennedy (1957) commented that with all the emphasis being placed upon the problems of the hard-of-hearing or deaf children, little attention has been paid to the fact that children's hearing is still being judged in relation to standards established for adults. Previous to this, Rossingnol (1948) suggested that data related to auditory acuity be interpreted affirmatively rather than negatively, thereby indicating the maturational development of hearing in children rather than inferring decrease in hearing deficiency with age.

Developmental Nature of Auditory Acuity

Bryant, as early as 1907, referred to the maturational development of the child's hearing when he stated that "the acuteness of normal hearing may be described by a curve which rises from zero at birth, attains its maximum at the completion of adolescence and gradually declines to a very low point in old age (cited by Kennedy, 1957:756)." Bryant supported his statement by a chart but included no data to indicate the extent of the groups from which the material was drawn.

Research studies of Foucault (1929), Chayer (1929), Kerridge and Saareste (1935), Black (1939) and the United States Public Health Service Survey (1935-1936) were other sources of data cited by Kennedy (1957) which would tend to substantiate the concept of hearing as a maturational phenomenon among various age groups. From evidence drawn from a group of 47 nursery school children between the ages of three and five-and-a-half years, Myklebust (1954) also found that the average threshold decreases toward the zero decibel line as the age increases. The hypothesis that acuity is a maturational process also seems to be supported from findings of recent investigations of Eagles (1961) and Eagan (1970). Recently, Oberg (1970), in her study of 160 children from Kindergarten to Grade Three, noted that children generally experienced more difficulty in hearing in the lower range of frequencies 250 and 500 cycles per second and in the higher frequencies of 4000 and 8000 cycles per second.

Kennedy's work (1942) is among the often quoted studies used to substantiate the idea that auditory acuity is developmental. Results of her research showed, like Oberg's (1970), that hearing in

the middle range of frequencies 1000 to 4000 cycles per second is more acute in the six-year-old than either the lower or higher frequencies. Kennedy (1957:761) concluded that:

(1) hearing is a maturational process without significant sex or laterality differences;

(2) like most other aspects of maturation this phenomenon does not present a straight line pattern but rather one of spurts and plateaus;

(3) different standards of hearing acuity are needed for the evaluation of different age groups below the adult level;

(4) failure to recognize age differences has resulted in misinterpretation concerning the feasibility and/or accuracy of hearing tests with young children;

(5) certain age groups deserve special attention in planning testing programs, because of the higher incidence of loss and the greater severity of difficulty at given age levels.

(6) for no age groups does the zero line appear to be flat.

Questions remain to be answered concerning the interpretation of children's audiograms indicating so-called decibel losses at specific frequencies. Although cross-sectional studies indicate that auditory acuity is developmental, longitudinal studies are needed to verify the findings of these cross-sectional studies.

Effect of Learning on Auditory Acuity

As pure-tone audiometers were used in studies by Myklebust (1954), Kennedy (1942) and Eagles (1961), Price (1964:91) questioned the findings of these studies with respect to the maturational development of auditory acuity. Kennedy (1942) had previously questioned how much of one's hearing ability was learned. Price (1964) contended that results of the above mentioned studies indicate the effect of

learning to listen abstractly, rather than maturation of auditory acuity; that is, the older children improved as familiarity with figure-ground discrimination increased. Dahl (1949), in an earlier study identifying several factors which would have a bearing on the relationship of auditory perception and reading achievement, indicated the relationship between auditory acuity and other facets of hearing in that they imply a level of maturation and of learning. Dahl (1949:14) concluded that:

> (1) incidence of impaired hearing is higher in the elementary school than in the high school;
>
> (2) hearing impairments occur more frequently among children from homes of low socio-economic groups than among children of high socio-economic levels;
>
> (3) hearing acuity is better among negro than among white children;
>
> (4) children of superior intelligence make better scores on the audiometer than do children of low intelligence when their hearing loss actually is the same.

Hardy (1960), in his definition of hearing, has stated that "hearing" is dependent on the two factors: maturation and learning. In agreement with Price's (1964) contention that children have difficulty in figure-ground discrimination, it is a known fact that some children experience difficulty distinguishing relevant stimuli from irrelevant stimuli. There is also some evidence that the mentally retarded seem to respond better to meaningful stimuli than to the more abstract pure-tone test (Myklebust, 1954).

The problem of differentiating between these two operating variables of maturation and learning arises particularly when testing young children. What effect does distractability, short-attention span, mental age and the ignoring of auditory stimuli have on the

audiometric testing of young children? There appears to be a need to develop systematic procedures in assessing decibel losses whigh might be related to such factors as inattentiveness to auditory stimuli. There is also a need to conduct research on ways in which attentiveness to auditory stimuli can be increased in individuals who tend to ignore the significance or meaning of sounds.

Relationship of Auditory Acuity to Reading

Most of the research which has attempted to correlate hearing loss with reading disorders has found that retarded readers have a high incidence of hearing loss. It is also known that the presence of a hearing loss does not necessarily result in a reading problem (Vernon, 1957). This perhaps becomes more understandable as one reviews the literature related to auditory acuity and becomes more aware of such underlying variables as attention, intelligence, and socio-economic status and the extent to which such variables may affect the maturation and learning of auditory acuity. Nevertheless, if a child has not developed sufficient acuity to differentiate sounds at the various frequency levels, it is plausible that the child may have difficulty with beginning reading. Although research indicates that acuity is developmental and that children beginning school have not reached the maximum development in distinguishing low-frequency and high-frequency tones, as yet there are no research studies available indicating the significance of developmental aspects of auditory acuity to the developmental aspects of the early reading process. Studies, nevertheless, are available showing a relationship between auditory acuity and reading achievement. These

investigations have significant findings and have added pertinent information to the field of reading knowledge.

The classic early study in the field was undertaken by Bond (1935). In comparing 64 Grade Two and Grade Three children with reading disabilities with 64 children of average and better reading ability, Bond found significant differences existed between the two groups with regard to auditory acuity, blending and auditory discrimination. Results of his research revealed 4 per cent of normal readers with a significant hearing loss compared to 63 per cent of the poor readers with impaired hearing. The implication of the study was that there is a difference in hearing acuity favoring the good readers. As Bond's study also included method in teaching, he postulated, as did Gray (1922), that hard-of-hearing children need not be poor readers if the method takes advantage of their perceptual strengths and does not emphasize their weaknesses. Bond (1935) found the differences between good and poor readers who were taught by phonic methods greater than those between good and poor readers taught by the look-and-say method. These findings would imply the importance of auditory acuity for children being taught by a phonic method.

Later Gates and Bond (1936) investigated four large classes of children who were given instruction in reading soon after entering the first grade. They found that a certain relationship did exist between hearing loss and reading achievement. Although the correlation was not particularly high, they did notice that the pupils in the near failing group showed a greater amount of hearing loss than did the group as a whole. Six out of ten were below average in hearing acuity and in three cases hearing loss was quite pronounced. Gates (1937)

not only considered defects of hearing to be a major cause of reading difficulties but stated that often teachers' unawareness of serious hearing deficiencies of pupils prevented pupils from understanding what was said or read to them.

Although Kennedy (1942) did not note any significant relationship between auditory acuity and reading achievement, she did observe that children with high-tone losses above 2048 double vibrations per second tended to become either very poor or very good readers. Kennedy further commented that high frequency loss of hearing tends to affect the discrimination of consonants which in English carry the intelligibility of the language. Henry (1947) also recognized the nature and importance of consonant sounds and hypothesized that acute hearing for high frequencies is of more importance to the child than is acute hearing for the low and medium frequencies. As a result of her study, Henry reported a statistically significant relationship between high-tone acuity and silent reading achievement, and therefore concluded the value of high frequency acuity for vocabulary development. Henry's study does not necessarily confirm Kennedy's findings regarding high frequencies because Kennedy determined high-tone losses above 2048 double vibrations per second, which Henry considered to be middle frequency tones. Unlike previous practices in scientific studies which determined the relationship of auditory acuity to reading achievement by using the best ear, Henry found the "worst spot" in hearing more reliable than the "best spot" to differentiate extreme reading groups. From her findings, Henry (1947) suggested that good binaural hearing accompanies success in reading.

Reynolds (1953:447), by testing binaural acuity for full range

and for low, medium and high tones, word discrimination, pitch discrimination, oral blending ability and auditory memory span, obtained eight auditory variables. While his low frequency of 128 and 250 double vibrations per second were identical with Henry's (1947), his middle frequency and high frequency divisions were slightly higher. Although Reynold's findings were negative with regard to hearing and reading relationships, there was some indication that success under some circumstances in word recognition ability and the learning of sound values for common word elements may be predictable auditory measures. Rossingnol (1948) had previously implied that keener acuity might be needed in the earlier stages of life when the child's language is rapidly developing. He also concluded that acuity is more important to the learning of unfamiliar words than to the understanding of familiar ones.

Other studies reviewed seem to indicate little or no relation between reading disabilities and impaired hearing. Malmquist (1958) declared that investigations of Illing and Bachman (1929) were unable to reveal any relation between reading disabilities and impaired hearing. Malmquist was also unable to observe any significant relationship either when carrying out investigations of all children in first grade by the use of whispering tests or when investigating children in the third grade by using the audiometer. In determining the relationship between auditory acuity and word recognition, Poling (1953: 409) concluded from her study of 78 poor readers that there were no statistically significant differences between the means of those with satisfactory and unsatisfactory auditory acuity in any area of word discrimination. Robinson (1955), examining poor readers with superior

and inferior auditory abilities, concluded that lack of auditory acuity was one of the least frequent causes of reading disability, while auditory discrimination and auditory memory span operated more frequently. At that time, she advocated the need for more adequate and reliable measures of these auditory abilities.

Recent investigations (Poling, 1968; Cosens, 1968; Oberg, 1970), which have included auditory acuity as a variable in relation to other auditory factors and reading, have tended to eliminate from the study children who have not reached a specified standard of auditory acuity as determined by the investigator. Although this procedure may have been designed as a control to eliminate one variable which might affect the findings of the study, research reviewed suggests that other variables are operative in determining the auditory acuity of a young child. This would suggest that lower acuity in hearing alone does not necessarily represent an auditory perceptual disorder, for research studies seem to indicate that lower acuity may improve with age as hearing matures or may be compensated for as learning occurs.

Summary

As subtle problems of hearing impairments occur frequently in primary school children, failure to recognize these problems and to make adjustments in the educational system points out the need of alerting educators to early and repeated assessment of hearing in young children. It would seem that audiometric testing is important early in the life of the child to detect whether he can distinguish between sound and no sound, to determine his maturational development

and to provide means of compensation for the handicapped child. Furthermore, longitudinal studies are needed to verify findings of cross-sectional studies indicating that auditory acuity is developmental or that lower acuity may be compensated for as learning occurs. With this in mind, no child will be eliminated from this study because of a decibel loss determined by audiometric testing.

For many years reading experts have mentioned hearing difficulty as a possible causal factor related to reading. It may be that hearing loss for some children has not interfered with the acquisition of language and, therefore, may not be significantly related to reading. Research studies are needed to determine the significance of developmental aspects of auditory acuity to the developmental aspects of the early reading process.

III. AUDITORY DISCRIMINATION

Relationship of Auditory Discrimination to Reading

While it is possible that some students who have not normal acuity are able to discriminate differences in sounds, it is also possible that some students with normal acuity are unable to distinguish between similar sounds in minimal word-pairs. That is, although a child has normal hearing acuity, he has not necessarily acquired the ability to make fine discriminations between sounds.

Several studies concerning the relationship of auditory discrimination to reading have suggested that reading disability might be associated with an inability to discriminate successfully the sounds in words (Monroe, 1932; Bond, 1935; Schonell, 1948). Monroe

(1932) initially explored auditory discrimination of Grade One children by using her own discrimination test which included 20 word-pairs pronounced by the examiner and responded to as "same" or "different". Results of the study indicated that the poor readers were significantly inferior to the better readers in the ability to discriminate between word-pairs. Later in the standardization of the Reading Aptitude Test, Monroe (1935) reported a higher relationship between a composite auditory score and end-of-first-grade reading achievement than between other types of readiness tests, such as visual and language tests and reading achievement. Despite the significant correlation of .66 between the composite auditory score and reading, no correlations were computed for the individual auditory sub-tests.

Gates et al. (1939) in a study of four New York City Grade One classes administered a battery of readiness tests which included a number of auditory discrimination subtests. After mean correlation coefficients were computed during the middle of Grade One, at the end of Grade One and in the middle of Grade Two, the correlation .20 discriminating word-pairs ranked the lowest of the six auditory discrimination tasks. In another study, Gates and Bond (1936) reported "fair" correlations between the readiness skills of word-pair discriminations, reproductions of letter sounds and nonsense words and subsequent success in beginning reading. Like Monroe (1932), Bond (1935) also emphasized the difficulty encountered by poor readers in the discrimination of speech sounds.

At the beginning of the next decade, Steinbach (1940) in administering a large number of readiness tests to 300 children entering first grade included only one measure of auditory discrimination, a

word-pairs test. Results of Steinbach's study (1940) showed that the auditory discrimination test with a correlation of .51 ranked second in terms of its relationship with reading achievement at the end of the school year, and ranked first with respect to its contribution to a multiple regression equation for the prediction of mid-year and end-of-year reading achievement.

Investigating auditory discrimination of speech sounds, Schonell (1948) found that in most cases of retarded readers with a deficiency in speech, a lower level of auditory discrimination rather than an organic condition was one of the most important and frequently occurring causal factors in poor reading.

In an extensive survey of auditory characteristics of 188 Grade Four children, Reynolds (1953) reported that auditory discrimination of word-pairs had low positive correlations of .29 and .40 with general reading ability, and significant correlations of .32 and .45 with word recognition ability in two of the four schools in the investigation.

Templin (1954), on the other hand, using the Rasmus-Travis Speech Sound Discrimination Test also tested Grade Four pupils and reported that correlations between reading scores and auditory discrimination scores were not significant. Previous to this study, Hall (1938), using the same test, found no significant relationship between scores on this test and reading achievement at either elementary or college level.

On the basis of an investigation regarding the relationship between ability to identify sounds in spoken words and reading achievement in Grades One, Two and Three, Durrell and Murphy (1953) reported

significant correlations of .56, .52 and .52. Thus, Durrell and Murphy concluded that the ability to notice separate sounds in spoken words is a very important factor in determining a child's success in learning to read.

Fast (1968) and Cosens (1968), using the Fast-Cosens Auditory Discrimination Test, both found auditory discrimination of Grade One children significantly related tc silent reading achievement. Cosens (1968) noted that correlations between auditory discrimination and oral reading were low and usually not significant. Recent investigators using the Wepman Auditory Discrimination Test have also reported significant correlations between discrimination and reading achievement (Deutsch, 1964; Christine and Christine, 1964; Reid, 1962; Thompson, 1963; and Poling, 1968).

Wepman (1960) assessed the auditory discrimination ability of 156 Grade One and Two children by using a minimal word-pairs test. On the basis of scores of auditory discrimination and articulation, children in both grades were divided into three groups. Wepman reported that children with poor auditory discrimination were more likely to be poorer readers regardless of whether or not they had a speech difficulty.

From data obtained in his study, Wepman (1960:326) developed the following theory of auditory discrimination:

> (1) there is evidence that the more nearly alike two phonemes are in phonic structure, the more likely they are to be misinterpreted;
>
> (2) individuals differ in their ability to discriminate among sounds;
>
> (3) the ability to discriminate frequently matures as late as the end of the child's eighth year;

(4) there is a strong positive relation between slow development of auditory discrimination and inaccurate pronunciation;

(5) there is a positive relation between poor discrimination and poor reading;

(6) while poor discrimination may be at the root of both speech and reading difficulties it often affects only reading or speaking;

(7) there is little if any relation between the development of auditory discrimination and intelligence as measured by most intelligence tests.

Generally research has shown that the development of auditory discrimination appears to be a maturational process; therefore, children develop auditory discrimination skills at different ages (Christine and Christine, 1964:98).

<u>Growth of Auditory Discrimination</u>

Although one of the generally accepted characteristics of auditory discrimination is growth, there is little agreement as to the age of optimum growth and as to the nature of the growth curve. Research has produced conflicting results concerning the relationship between chronological age and auditory discrimination. Carhart (1947:249) has suggested that many children by the age of three have learned to make the auditory discriminations which the world requires of the average adult. On the other hand, Vernon (1957:62) has stated that the ability to perceive and remember word sounds accurately requires an attention span and an accuracy of hearing beyond the capacity of many children at the time they enter school.

Dykstra (1966:16), in reviewing research pertinent to his study, stated that age does not appear to be a significant factor in determining whether or not skill in auditory discrimination is related

to reading. As Dykstra found from his study of Grade One children that correlations between chronological age and the ability to make auditory discriminations were definitely not significant, he concluded that older children in first grade exhibit no greater skill in auditory discrimination than younger children. Poling (1968:77), recognizing the extremely rapid maturation typical of a Grade One age group, attempted to minimize the possible influence of chronological age on the experimental variable by matching pupils within one or two months. Her findings, indicating a decreasing number of children with poor auditory discrimination as age increased, substantiated the findings of Wepman (1960:330).

Although chronological age may be thought of as the variable that influences the process of hearing likenesses and differences between similar sounds, it may be that age may be considered as a macrovariable, according to Winitz (1969:141), formed from several other variables. The following variables to be discussed in the next section and to be investigated in the study may be elements of this macrovariable:

(a) developmental aspects of auditory discrimination

(b) sex

(c) intelligence

(d) cultural environment.

<u>Developmental Aspects of Auditory Discrimination</u>

The developmental nature of the process of discrimination is shown by the decreasing number of children who exhibit discriminatory problems at each higher age level (Poling, 1968; Thompson, 1963;

Eagan, 1970; and Oberg, 1970). The exact maturational sequence in auditory discrimination and the time at which to develop the maximum capacity for auditory discrimination are not known. Furthermore, as maturation and learning are two basic processes which almost always interact, it is difficult to separate the effect of learning from the process of maturation and to determine the effect of maturation on the process of learning. Development, therefore, may be considered as the changing end-product resulting from the interaction of maturational and learning factors.

Several research studies have indicated that auditory discrimination is developmental (Myklebust, 1960; Goins, 1959; Christine and Christine, 1964; Fast, 1968; and Oberg, 1970). Results of the longitudinal studies of Thompson (1963) and Poling (1968) also seem to suggest the developmental aspects of auditory discrimination. Thompson (1963:375) completed a longitudinal study of the performance of 106 Grade One children using three auditory discrimination tests: A Test for Auditory Discrimination, Form A; Boston University Speech Sound Discrimination Picture Test, and "Auditory Discrimination and Orientation", a subtest of the SRA Reading Analysis, Aptitude, Form A. As a secondary problem of her two-year study, 1958-1960, Thompson (1963) studied the auditory discrimination of children attending Grades One and Two. The 106 children included in the study were administered the three previously mentioned auditory discrimination tests in the month preceding entrance to the first grade and in the eighth month of the second grade. From the composite performance score of this sample on the three auditory discrimination tests, Thompson concluded that inaccurate discriminative ability is more characteristic of first grade

entrants than accurate ability. Although the reverse is true at the end of Grade One, nevertheless, approximately 24 per cent of the sample had inaccurate auditory discriminative ability. Only one child in the study who had achieved adequacy in auditory discrimination became a poor reader, while approximately half of the children with inaccurate auditory discriminative ability were classified as poor readers. It was noted that the poorer readers made greater proportional gains than the good readers in auditory discrimination. The fact that gains were made by all groups might indicate the general development of auditory discrimination ability in most primary children. Besides showing that auditory discrimination ability of Grade One children was developmental, results of Thompson's study (1963) also showed that children's auditory discrimination ability at entrance to school was highly prognostic in determining who would become a good reader.

Results of Poling's (1968) study also revealed that children with better auditory discrimination ability at the beginning of Grade One were better readers at the end of Grade Two even though there was no significant difference between subjects who were poor discriminators at the end of Grade One and the good discriminators at the end of Grade One. From her investigation Poling (1968) also determined experimentally the reliability of the unstandardized but clinically successful Wepman Auditory Discrimination Test. As a result of her study, Poling questioned the effect of the factor of intelligence on auditory discrimination. She also questioned whether a child must be able to remember sounds before he can discriminate between them or whether he simply fails to make the discrimination. She thereby suggested, as Flower (1968) did, that it is exceedingly difficult and

perhaps impossible to measure one variable without to a slight extent measuring the other also.

Although studies of Oberg (1970) and Eagan (1970) were not longitudinal studies such as Poling's (1968), their results seem to substantiate Poling's finding that auditory discrimination is developmental and that adequacy in auditory discrimination ability is not acquired by some children until the end of Grade Two or Three. Oberg (1970:143) concluded that "ability in auditory discrimination appears to be a developmental process from Kindergarten to Grade Three inclusive, as indicated by the gradual increase in mean auditory discrimination test scores at each successive grade level."

Relationship between Auditory Discrimination and Sex

Since auditory discrimination is a developmental process and girls mature physically more rapidly than boys, it has been postulated by some investigators that girls' auditory abilities develop at a faster rate than boys (Wepman, 1960; Dykstra, 1966, Spache, 1966; and Wyatt, 1966). McAulay (1965:208) from her study concluded that "superior performance of the girls on tests of auditory and motor aptitude suggests that maturational sex differences may be a factor that is operative in the girls' favor."

Although Cosens (1968) reported that boys were slightly superior to girls on total auditory discrimination scores as well as on the auditory discrimination of all speech sound types, there were no significant differences between mean test scores of boys and girls on any auditory discrimination scores except like pairs. The fact that boys were significantly superior to girls on like word-pair items may

indicate that the boys were more advanced in auditory discrimination, as they reached the level of seeing similarities in word-pairs before the girls. Eagan (1970) and Oberg (1970) as well as Poling (1968) also reported that boys were slightly higher than girls at some grade levels but the differences were not significant. Research of Cosens (1968), Poling (1968), Oberg (1970), and Eagan (1970) indicates boys at times can be expected to obtain scores in auditory discrimination which are as high as or possibly higher than those of girls. Betts in 1957 had cautioned that sex differences with respect to language development may be over-emphasized as there is a considerable overlap between sexes.

Reid (1962) noted that while there was a significant difference between boys and girls at the beginning of Grade One, results of re-testing near the end of the school year failed to indicate any significant relationship between boys and girls. Findings of studies conducted at the end of the school year suggest the interacton of maturation and learning influenced by the common auditory and language experiences during the school year which may serve to lessen the differences between the sexes (Reid, 1962; Cosens, 1968; Poling, 1968; Oberg, 1970; Eagan, 1970; and Moffatt, 1970).

Templin (1963) has suggested that the variable of sex is probably of little significance for a general theory of language development. According to Templin many of the recent studies do not show sex differences because of the increasing equanimity of the "speech environment". While this conclusion appears tenable, research studies previously mentioned indicate environment alone does not affect auditory discrimination and other aspects of language development, but

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environment together with maturation and learning does.

Relationship of Intelligence to Auditory Discrimination

Another variable to be considered an element of the macro-variable of growth and to be related to auditory discrimination is the factor of intelligence. Research studies into the important question as to whether auditory discrimination is an auditory factor or a factor of intelligence have been contradictory in their conclusions. In general, research seems to indicate that auditory discrimination has intellectual components but may not be fully measured by intelligence tests (Hall, 1938; Thompson, 1963; and Poling, 1968).

As a result of a two-year longitudinal study to determine the relationship of auditory discrimination and intelligence test scores to success in primary reading, Thompson (1963) reported that auditory discrimination and intelligence are highly correlated with success in primary reading. From the high intercorrelations of the factors of auditory discrimination and intelligence, Thompson (1963) concluded that adequacy in one trait might frequently be accompanied by adequacy in the other at the beginning of the first year of school. From the lower correlations in which Performance Scale I.Q. scores of the WISC were used, Thompson concluded reading to be a highly verbal skill. Thompson's conclusions suggest that correlations between auditory discrimination and intelligence depend to some extent on whether an intelligence test is measuring verbal or non-verbal ability.

Poling (1968), in her study, also questioned the possibility of auditory discrimination being a high order of auditory ability with intellectual components. Poling (1968) used the Thurstone Test of

Primary Mental Abilities measuring verbal meaning, perceptual speed, quantitative, motor and spatial abilities. Poling reported that perceptual ability as measured by the PMA is unimportant to auditory discrimination but that quantitative ability as measured by the PMA is highly important both to auditory discrimination and to reading achievement. Poling further observed that perceptual and spatial ability are more important to reading when visual skills are stressed and that verbal and quantitative scores are more important at the second grade level where word analysis is stressed. From these results the supposition may be made as to the importance of previous knowledge, of language acquisition, of vocabulary knowledge and of memory to the relationships that may exist among auditory discrimination, intelligence and reading. It must be remembered, however, in interpreting Poling's findings with respect to auditory discrimination and intelligence and reading, that pupils with intelligence quotient scores below 90 were eliminated from the study. Therefore, findings may only be applied to children with average or above average mental age as determined by scores on the PMA. From her study, Poling (1968) concluded that, in general, children with good auditory discrimination and above average mental age can be expected to become superior readers and those children with poor auditory discrimination and average mental age may be expected to become average or poor readers. However, the fact that some children of above average mental age will manifest inadequate discrimination and that some children of average mental age will have acquired a high level of competency in auditory discrimination should also be anticipated. While there is a positive relationship between auditory discrimination and intelligence, there is some evidence that

auditory discrimination is not fully measured by intelligence test scores.

Wepman (1961) who had obtained a .32 correlation between auditory discrimination ability and intelligence, as measured by the Kuhlman-Anderson Intelligence Test, concluded that the low positive correlation pointed to the comparative independence of discrimination from intelligence. Wepman agreed, however, that generally the more intelligent children appear to do somewhat better in discrimination. He attempted to explain this seemingly intellectual factor quite simply by stating that, to a mild degree, attention to the auditory task is necessary for discrimination to function at its best. Therefore, a child with high intelligence scores better because he attends to his task better. In the light of Wepman's comment with respect to attention, the factor of attention and its importance and relationship to factors of auditory discrimination and intelligence will be discussed later in this chapter.

Although research studies generally agree that there is a positive relationship between intelligence and auditory discrimination, the extent of the relationship varies with each study (Christine and Christine, 1964; Hall, 1938; and LaPray and Ross, 1967). The fact that the magnitude of the relationship between auditory discrimination and intelligence is not known may be due in part to the type of tests of auditory discrimination and intelligence that are being correlated.

In order to predict success in beginning reading, Dykstra (1966) attempted to correlate seven auditory discrimination measures, intelligence quotient scores, as measured by the Lorge-Thorndike Intelligence Test and chronological age, with two aspects of reading

achievement. From this investigation a number of relevant conclusions were drawn. As would be expected, Dykstra reported that the prediction of beginning reading success is a difficult task even when information is available concerning performance on seven measures of discrimination, intelligence and chronological age, at the beginning of first grade. He further stated, that if the aim of readiness testing is to predict success in beginning reading, there is little justification for assessing auditory discrimination ability in addition to intelligence. When examining conclusions drawn from Dykstra's study, it must be remembered that Dykstra is investigating the predictability of variables in relation to beginning reading. From the analysis of the data, findings indicated that intelligence by itself accounted for 21 per cent of the variability associated with word recognition. This finding may also indicate the relative importance of other variables, such as auditory discrimination, in accounting for the remaining variability that might be associated with word recognition.

Upon further examination of the analysis of the data, correlations indicated that intelligence and auditory discrimination tasks with relatively low correlations from .20 to .45 were significantly related to word recognition and paragraph meaning. On close examination of these correlations, it was observed that ability to discriminate between spoken words which do or do not begin with identical sounds, as measured by the Harrison Stroud Making Auditory Discrimination Test, showed a higher correlation of .35 with intelligence than with other auditory discrimination measures. While the Harrison Stroud Making Auditory Discrimination Test appeared to require children to complete one of the easiest auditory tasks, it may have

obtained higher correlations than other auditory measures at this level because fewer determining factors were involved, for example, factors which would be required in the more difficult auditory discrimination tasks and a verbal intelligence test. These factors might be listed as verbal ability and awareness of auditory discrimination tasks. This might indicate that intellectual factors and other auditory variables may have been operative during the administration of both the various auditory discrimination tests and the intelligence test. Dykstra (1966) commented that essentially the same skill--for example, being able to determine whether or not two words begin with the same initial consonant--may be measured by two somewhat different techniques. Therefore, if one auditory discrimination task requires more verbal ability than another auditory discrimination task, it may be that a comparable intelligence test of verbal ability should be administered if correlations between auditory discrimination and intelligence are to be conclusive.

Deutsch (1964) would tend to support the preceding statement as she reported that results of her study involving the relationship of auditory discrimination and intelligence was a little obscured by the use of different intelligence tests. Deutsch's findings (1964) were generally supportive of the correlation between intelligence and auditory discrimination, and seemed to substantiate the postulations of Thompson (1963). She reported a meaningful relationship of .52 between results on the Wepman test and the Verbal Scale of the Wechsler Intelligence Scale for Children when administered to retarded readers in Grade Five, and a less significant relationship .30 for average readers in Grade Five. Data were also presented by Deutsch (1964)

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indicating that the relationship between auditory discrimination and verbal intelligence is greater in Grade One than in Grade Five.

In reference to the study involving Grade One children, Deutsch (1964) commented that while the correlation .50 between the Wepman Auditory Discrimination Test and the Peabody Picture Vocabulary Test was significant at the .01 level; the correlation .14 between the Wepman and the Lorge-Thorndike Intelligence Test was not significant. As the Peabody Picture Vocabulary Test is an intelligence test measuring verbal behavior and the Lorge-Thorndike Intelligence Test at the Grade One level is measuring non-verbal behavior, Deutsch (1964) postulated that results of this finding may be confirming, as was previously noted by Thompson (1963), that auditory discrimination, in this instance, in relation to the Wepman Auditory Discrimination Test, may correlate with verbal measures. It was further noted that test results of poor readers showed higher correlations between auditory discrimination and verbal intelligence measures and that those of younger children also showed a greater relationship between the auditory measures and the verbal intelligence measures. Therefore, Deutsch (1964) concluded that a particular minimum level of auditory discrimination skill is necessary for the acquisition of general verbal skills and reading. Once this minimum level is reached, auditory discrimination may no longer highly correlate with intelligence and reading ability.

Relationship of Attention to Auditory Discrimination

Perhaps the factor which may be of importance to auditory discrimination, and intelligence and beginning reading is the factor of

"awareness" or attention to appropriate stimuli. Wepman (1961) suggested attention as the ability possessed by the child with high intelligence which influences his auditory discrimination ability. This ability to "attend to" may also reflect the influences of environment and learning on auditory discrimination, intelligence and beginning reading.

James (1890:403), one of the first modern experimental psychologists, has written:

> Everyone knows what attention is. It is the taking possession by the mind in clear and vivid form of one out of what seems several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others.

Although everyone knows what attention is, there is little research available about the most efficient way to teach the child to attend to auditory stimuli. The difficulty perhaps is in the assessing of attention. Ordinarily attention to auditory stimuli is inferred from the subject's responses such as facial expressions, movement of the head, or verbal or motor responses. Therefore, there is need to develop systematic procedures, not for assessing attentiveness, but for assessing the reasons for what appears to be inattentiveness to auditory stimuli.

Vernon (1962:172) states that the theory has been put forward that "levels of attention vary from the highest, at which attention is focused and narrowly concentrated upon a particular part of the field, to the lowest, a bare consciousness of the marginal parts of the field." To a greater or lesser extent these fluctuations of attention depend upon "conditions within the individual himself--his general health,

his state of fatigue, his interest in his task and the strength of his motivation for maintaining attention."

With respect to auditory aspects of attention, certain physiological processes in the brain have been discovered and investigated which appear to be related to the arousal, direction, and maintenance of attention. Physiological investigations cited by Vernon (1962) suggested that the nervous tissue with the brain stem and the reticular formation, a region of the thalamus, play a part in regulating the passage of sensory impulses to the cortex. These physiological mechanisms have the capacity to direct and heighten attention to particular aspects of auditory discrimination which are of significance to the individual, while at the same time suppressing distracting and irrelevant aspects.

Deutsch (1964) has also referred to auditory discrimination as clearly a function mediated by the nervous system which can be profoundly influenced by the condition of life in the individual. Deutsch postulated that auditory stimuli are particularly prone to a "tuning-out" process, to a learned inattention. As auditory stimuli are always present, hearing is largely a background sense, and therefore, the impingement of the physical properties of sound cannot be avoided (Myklebust, 1960). As a result, the very young child before coming to school, at a time when he might most easily learn discrimination, may be encouraged by the stimulus properties of his environment to "tune-out", to become inattentive to appropriate auditory stimuli. This emphasizes the importance of the experiences in the early life of the child with respect to the acquisition of language, more specifically to the development of adequate auditory discrimination.

Besides the physiological mechanisms related to attention and perception, Vernon (1962:195) notes that objects perceived in a complex field and the clarity and accuracy with which they are perceived appear to be related to the observer's interest in them. Moreover, it may be said that when a child perceives something because he is interested in certain things, it is often implied that he is both knowledgeable about them and that he is eager to perceive and learn more about them. Perhaps the intelligence factor related to attention may be in "knowing" what to attend to. This would then imply a certain amount of learning and experience, as well as some previous knowledge. As Vernon (1962:157) indicates, an observer's perception may be made more rapid and accurate if his attention is directed towards it. As the attention becomes more narrowly and specifically directed and the amount of training and experience becomes more clearly defined, the improvement and the effect is likely to be greater. Thus focalization as mentioned by James (1890) and "awareness" and "knowing" what to attend to, as mentioned by Vernon (1962), appear to be fundamental to auditory discrimination. Thus one of the factors which influences the relationship between auditory discrimination and intelligence may be this factor of "knowing" what to attend to.

Attention as such is difficult to define, but everyone is aware that when he wants to perceive something clearly and correctly, he concentrates his attention upon it. In some instances, it may be these processes of attention and concentration influenced by interest, which differentiate auditory abilities in children, either enhancing or impeding their performance of auditory tasks and thereby influencing or hindering progress in beginning reading.

Clark and Richards (1966:259), as a result of their research in relation to auditory discrimination and socio-economic status, reported that a most evident and relevant variable in their study was motivation for attending to the task. Motivation, which affects interest as well as attention and concentration, should be considered as a prime factor in relation to auditory discrimination and beginning reading.

Jenkinson (1964) has stated in relation to reading that interest will determine not only whether an individual will learn to read but how well he will learn, how much he will read, and in what areas he will read. Jenkinson further stated that central to the function of interest appears to be the fact that interest directs and focuses the learner's attention on the task in hand and thereby mobilizes energy which may result in the formation of the important habit of concentration. If auditory discrimination is basic to the decoding process of reading, then Jenkinson's statement stressing the importance of interest, attention and concentration to reading may also be applied to the fundamental process of auditory discrimination.

Relationship of Cultural Environment to Auditory Discrimination

Although socio-economic status will not be investigated in this study, the investigator realizes that the conditions under which children live, particularly early in life, are going to affect auditory skills in a predictable way. Socio-economic status may be considered to be an element of the larger macrovariable of cultural environment. Recent research studies have stressed the importance of the relationships that exist between language development and

socio-economic status and between auditory discrimination and socio-economic status (Fast, 1968; Deutsch, 1964; Mortenson, 1967; and Moffatt, 1970).

Mortenson (1967:547), investigating the discrimination ability of 1500 children, reported that the higher the socio-economic status of the beginning Grade One child, the higher the performance on auditory tasks and on intelligence tests. When intelligence was held constant, the higher socio-economic child performed significantly better on all of the auditory discrimination tasks with the exception of auditory discrimination of vowels. Moffatt (1970:60), using the California Short Form Test of Mental Maturity and The Vowel and Semi-vowel Auditory Discrimination Test, reported a significant correlation of .43 between intelligence and auditory discrimination of vowels. While Moffatt did not make any comparisons between socio-economic status and auditory discrimination of vowels in his final study, he did make comparisons in a pilot study. From the small sample in a pilot study, Moffatt (1970) reported that the high socio-economic group did better than the lower socio-economic groups in auditory discrimination. At the same time, though, Moffatt (1970) reported that the boys in the lower socio-economic group did better in the auditory discrimination task than the boys in the middle socio-economic group. Moffatt explained these results by noting that the boys in the middle socio-economic group were more restless than the other children in the sample and, therefore, less attentive.

Research studies, in general, have shown a positive correlation between socio-economic status and auditory discrimination (Edwards, 1965; Silberman, 1964; Raph, 1965; Deutsch, 1964; Clark and

Richards, 1966; Mortenson, 1967; and Fast, 1968). Perhaps these studies are emphasizing not only the relationship between socio-economic status and auditory discrimination but also the importance of the environment of the child in relation to the acquisition of language. In other words, studies are stressing the importance of the interaction of maturation and learning in a specific environment on the language development of the child. Therefore, the ability to distinguish very subtle differences in sound which are essential to beginning reading may prove more difficult in some instances for one child than for another, because of an early environment which stifled or impeded the child's response to speech sounds.

Raph (1965), reviewing studies of language development of low socio-economic status children, stresses the importance of environment to the development of language, in relation to experiences and motivation in the early years in the life of the child. Because of the lack of stimulation in these early years Raph concluded, in speaking of the development of socially disadvantaged children:

> Distinctive qualities of their language and speech include a deficit in the auditory-vocal modality greater than in the visual-motor areas, a meagerness of quantity and quality of verbal expression which serves to depress intellectual functioning as they grow older and a slower rate and lower level of articulatory maturation (Raph, 1965:389).

Other researchers have also stressed the importance of environment to the development of language in the life of the child (Hunt, 1964; Armstrong, 1961; Edwards, 1965; and Deutsch, 1964).

In stressing this importance of environment, Deutsch (1964:278) commented that it is possible to have fully intact end-organs, i.e., to have vibrations received and transmitted by the ear, and still not

be able to discriminate or to understand or to recognize sounds. As crucial to discrimination and recognition as the intactness of the brain are the variables having to do with experience and exposure to adequate stimuli. It is only through experience which involves consistent exposure to auditory stimuli that the child comes to discriminate between sounds, to recognize words and to relate them to referents and ultimately to use words himself. It is important for the child not only to be exposed consistently to auditory stimuli, but to be enriched with a variety of stimuli. This would aid in developing his ability to differentiate sounds and would facilitate the development of auditory discrimination. Hunt (1964) contends that the greater the variety of situations to which the child must accommodate his behavioral structures, the more differentiated they become.

Although the link between hearing and speech is obvious, the relationship is not a unitary one. The quantity and the quality of the speech sounds which the child hears and the circumstances under which the stimulation occurs will affect developmental aspects of the language acquisition. This stresses the importance of the nature of the total-environment of the child and the importance of the child's being called upon to respond to particular stimuli which will reinforce the frequency, the quantity and quality of response. Thus, the child learns to become attentive to appropriate stimuli in his environment. If the child does not make sufficient progress in oral language, he is likely to be inadequate in the associating of sound and symbol in beginning reading.

Summary

Research studies suggest that children entering Grade One can be expected to manifest wide variation in adequacy of auditory discrimination. While children improve in auditory discrimination, auditory discrimination may not be fully acquired by some children until the end of Grade Three. As research has yielded contradictory findings in assessing the relationship between chronological age and auditory discrimination, further research is needed to determine the nature of growth curves. Generally, research has shown that auditory discrimination is developmental. If development is considered as the changing end-product resulting from interaction of maturational and learning factors, further research is needed to verify developmental studies and to determine if there is a maturational sequence in auditory discrimination and the time to develop maximum capacity of auditory discrimination.

Varying relationships, depending upon the sampling as well as techniques used, are reported between auditory discrimination and reading. As results of studies range from substantial correlation relationships to no relationship at all, techniques should be examined and used to investigate aspects of auditory discrimination ability which may be important and common to success in early reading.

From available data, it does not appear possible to draw any definite conclusions concerning the superiority of one sex over the other in relation to auditory discrimination ability. As boys and girls today seem to have a common "speech" environment, cultural differences between sexes with respect to language development have narrowed. Results of studies indicate that girls as well as boys may be

characterized by inadequate auditory discrimination and delayed language development and thereby have difficulty in beginning reading. Nevertheless, research also indicates that more boys have difficulty in reading. Therefore, it remains to determine what causal factors other than sex impede boys' progress in early reading.

While auditory discrimination and intelligence are related to some degree, the relationship appears to be affected by the verbal content of the intelligence test. As intelligence has usually been treated globally with respect to auditory discrimination, research is needed to consider individual factors thought to constitute "intelligence" and to determine the extent to which such factors influence auditory discrimination in relation to beginning reading. At the time the child usually begins to read there appears to be a relationship between intelligence and auditory discrimination both of which are dependent upon maturation, learning and the environment of the child. With respect to the development of the child, three factors - interest, attention and motivation - are basic to the fundamental processes of "awareness" and "knowing what to attend to". This ability to "attend to" may reflect the influences of environment and learning on auditory discrimination, intelligence and beginning reading. As there is little research available about the most efficient ways to teach a child to attend to auditory stimuli, there is need to develop systematic procedures to assess what appears to be inattentiveness to auditory stimuli.

Relationship of Articulation of Speech Sounds to Auditory Discrimination

If auditory discrimination is reflected in a child's speech,

then it is important to consider the development of articulation of speech sounds. Durrell (1968:19) states that the child's phonics program begins with learning to speak, and "that about one-third of the children entering first grade need special training to bring the sounds in spoken words to their attention. If the child is not made aware of the phonemes in his speech, he may not learn to read."

As reported by Templin (1957:53), research studies (Poole, 1934; and Wellman, 1931) indicate substantial agreement in the approximate order of development of correct articulation of consonant sounds. Table 2.1 indicates the ages at which consonants are acquired naturally. Templin (1957) found that all vowels and diphthongs were articulated correctly by 95 per cent of her sample by age six. From her study, Templin (1957) hypothesized that development of vowel sounds would also influence the discrimination and articulation of consonant sounds.

Leopold (1971:135) stated, "The child learns to distinguish passively and actively, low vowels from high vowels, then the mid vowels and eventually the breakdown of these three major levels into still more refined subdivisions. It also appears that a twofold distinction is made between front, back and central vowels."

As Olmsted (1966:531) theorized that "learning as measured by correct pronunciation is a function of ease of perception of sounds", the assumption was made that a close relationship exists between articulation and discrimination of speech sounds. Weiner (1967:23) concluded that a positive relationship between auditory discrimination and articulation is almost invariably found in studies of children below nine years of age, and seldom found above that level. However,

even in this younger group correlation studies indicate that the degree of adequacy in auditory discrimination has only a small though positive relationship to proficiency of articulation (Templin, 1957).

TABLE 2.1

LATEST AGE AT WHICH CONSONANTS ARE ACQUIRED NATURALLY
(Poole, 1934)

Age	Sounds Mastered
3-½	b-p-m-w-h
4-½	d-t-n-g-k-ng-y
5-½	f
6-½	v-th(then-sh-zh-1)
7-½	s-z-r-th(thin)-wh-ch-j

As early as 1938, Cole noted that the average six-year-old does not distinguish consistently between /g/ and /k/, /m/ and /n/, and /d/ and /p/. More recently in testing the articulation of Kindergarten children, Calfee and Venesky (1968) found that initial /b/ was mispronounced three times in "birch" and forty times in "beige". They concluded that these differences might be attributed to familiarity or word frequency but the /k/ errors in "coins" (3) and "cage" (33) could not. Thus they suggested the importance of phonetic environment, the ability to articulate one sound in relation to other sounds.

This finding suggests the importance of distinguishing phonetic development in words from phonetic development prior to word learning. The former may, in part, have a physiological basis; the latter a

physiological basis only in the sense that it supplements, or perhaps helps to explain, in part, the use of an abstract phonological rule when maturation is sufficient. A valid inference from studies just reviewed is that maturation of one or more physiological processes is not of great significance in determining the age-by-age development of consonants after age three. Although articulation may be considered developmental, there is no comparable sequence of orderly development apparent for phonemes. Although some sounds may be uttered by some children at age three, this does not necessarily mean they are mastered at age three, for some sounds that are not mastered until seven years of age may be uttered by many children at age three. Therefore, phoneme development with respect to the production of speech sounds may be viewed as orderly if one simply defines mastery as the age at which the correct production of all variants of a phoneme in all word position and contexts is achieved. While phoneme development with respect to the production of speech sounds involves phonetic production learning, like the discrimination of speech sounds, it also involves the learning of phonology with all its rules.

Relation of Phoneme Acquisition to Auditory Discrimination

Every language is composed of a set of rules, a "structured system" which needs to be learned by both the speaker and the listener. Language has been defined by Carroll as:

> . . . a structured system of arbitrary vocal sounds and sequences of sounds which is used or can be used in interpersonal communication by an aggregation of human beings, and which rather exhaustively catalogs the things, events and processes in the human environment (1953:10)

It would seem that the knowledge of phonemes and the rules of

sound usage would determine the way the sounds of language are used. Phoneme acquisition involves the learning of the acceptable phoneme sequences of the language that signals semantic distinctiveness. As Carroll (1964:13) states, "Phonemes are the building blocks out of which meaningful or grammatically functional forms are composed, furthermore, they provide the critical basis for differentiating among these forms." As this study is primarily concerned with the sound acquisition of one-syllable words with respect to the auditory discrimination of labial stops and nasals in the immediate environment of the "simple" vowel, the discussion with regard to phonemic acquisition and distinctions will evolve around these phonemic variables of the study.

For the child there appears to be two varieties of language--one he controls actively and the other, the speech of adults, he controls only passively. "According to the findings of phonetically trained observers and the summary statement of Gregoire, the child in the peak of the babbling period is able to produce 'all conceivable sounds' (Jakobson, 1968:21)." This babbling period of the child and the child's understanding of speech, without speaking, seem to prove that the child lacks neither the vocal-motor ability nor the acoustic ability, yet, in spite of this, he suddenly loses most of his sounds. Not only do articulations which are lacking in the child's linguistic environment disappear during the transition from the "pre-language stage" to the "first stage of genuine language", but also the many other sounds which are common to the child's linguistic environment. According to Jakobson (1968:22) and Velten (1943:281), it is only after a long struggle over a period of several years, that the child regains the sounds appropriate for the language of his environment.

Like Van Ginnekin (Jakobson, p. 51), who characterized the manner of language development of the Dutch child, it may be said that the language development of the English child evolves from a general human language to English. It appears that children pass from a wealth of unintentional vocalization to a selection of specific sounds for communication. That is, a child who uses only /p/ and /m/ and /a/ in speech will at the same time use /k/, /g/ and many other sounds in nonspeech (Jakobson, 1941). Jesperson remarked:

> It is strange that among an infant's sounds one can often detect sounds - for instance, k, g, h, and uvular r - which the child will find difficulty in producing afterwards when they occur in real words . . . The explanation lies probably in the difference between doing a thing in play or without a plan--when it is immaterial which movement (sound) is made--and doing the same thing with fixed intention when this sound and this sound only is required (Jesperson, 1925:106).

It would seem that with the first appearance of phonemes, something other than the physical ability to produce a multitude of speech sounds has disappeared. Instead of continuity in sound utterances there is discontinuity once the sounds are uttered with meaning. During this "first stage of genuine language", the child seems to acquire a phoneme system by proceeding, step-by-step, from the greatest possible phoneme distinction to smaller and smaller differentiations (Velten, 1943:282).

Jakobson (1941) has been one of the first linguists among psychologists to distinguish the learning of phonemic contrasts from simply babbling. In 1941, Jakobson described the sequence in which phonemic contrasts seem to emerge in any language. Later, in 1956, with Halle, he set forth such a sequence in terms of "distinctive

features."

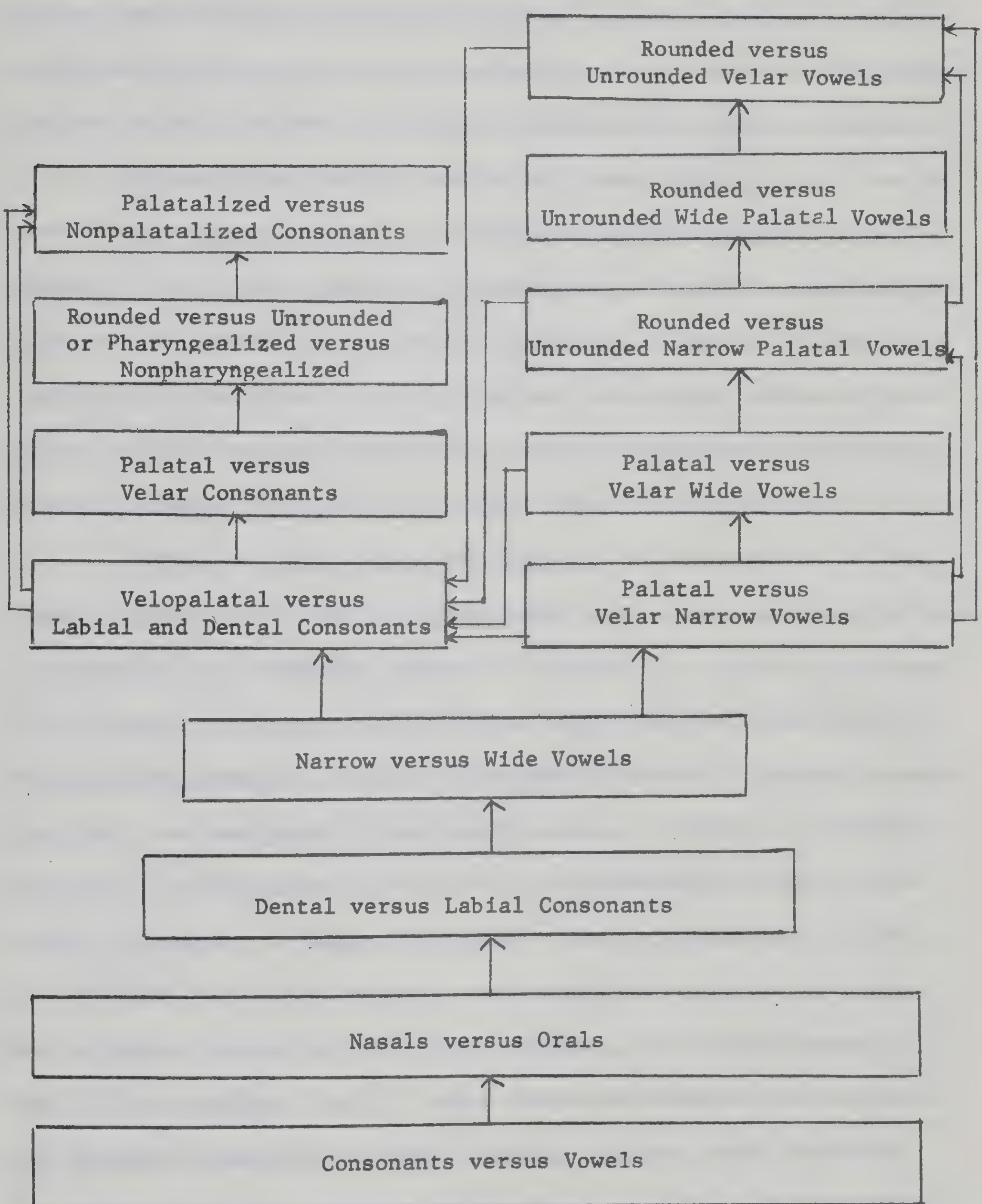
> The "distinctive features" of an individual phoneme would be those aspects of the process of articulation and their acoustic consequences that serve to contrast one phoneme with others. In English speech the phoneme /b/ is always a stop . . . and in this respect it contrasts with a phoneme such as /v/ which is a fricative. The /b/ phoneme is also voiced and in this respect, it contrasts with /p/. Jakobson, Fant, and Halle (1952) have proposed that any phoneme may be described as a bundle of concurrent distinctive features (Berko and Brown, 1960:525).

Therefore, the phonological component of language as conceived by Jakobson and Halle (1956) makes use of a finite set of phonetic features.

Table 2.2 is an adapted pictorial representation of Jakobson and Halle's model for the development of phoneme contrasts (Winitz, 1969:91). From this table it may be seen that some contrasts are prerequisites for other contrasts. While the serial order of sound acquisition appears to be stable for all children, the tempo of these successive acquisition is inconstant and individual. Velten (1943:282) reported, in reference to remarks of Gammont, that some children have acquired the standard phonological system of their parents' speech at the age of eighteen months, while others of equal mental and physical ability do not pronounce certain phonemes until they are six years old or even older. Jakobson (1968), in reporting the tempo of successive acquisitions, stated that while two sound acquisitions for one child may follow immediately after each other, for another child these sound acquisitions may be separated by several months, even by several years. Thus, it may be that some children coming to school have acquired the phonological system of their mother tongue while other children may still exhibit childish traits. As a result of these differentiations

TABLE 2.2

PICTORIAL REPRESENTATION OF JAKOBSON AND HALLE'S MODEL
FOR THE DEVELOPMENT OF PHONEME CONTRASTS



SOURCE: Adapted from Jakobson and Halle, 1956. Cited by Winitz, 1969:91.

in phonological acquisition, it may be that some children enter school with wide differentiations in auditory discrimination ability. The differentiations in phonological acquisition may also explain to some extent the difficulty experienced by some children who have acquired the phonological system of their mother tongue which may not be English, and who as yet have not acquired the phonological system of English.

On examining Jakobson and Halle's model, Table 2.2, it may be seen that the first contrast that appears is the consonant versus vowels. This first opposition to appear is, as would be expected, the distinction between the two basic phonological classes. It may be justified on the ground that it is a more elementary problem to perceive the distinctions between one class of perceptions and another, than to perceive those within the same class of perceptions.

During the first stage of language, the construction of the vowel system is initiated by a wide vowel and at the same time the construction of the consonant system is initiated by a stop at the front of the mouth; /a/ emerges as the first vowel and the labial stop /p/ as the first consonant. As an accompanying feature of vowels is voicing, with the emergence of the vowel-consonant contrast the opposed feature of voicelessness stands out as a concomitant feature of the latter. However, as Velten (1943:283) noted, although many children use at first only voiceless oral consonants, the variation of voiced and voiceless sounds is by no means uncommon. The labial stops /p/ and /b/ combined with the /a/ sound create the model of the syllable, the phonemic framework for which phonemic content is now required. From this early stage of many children's speech, the universal rule that morphemes are composed of no more than two different phonemes

persists even after the late-distinctive phonemes such as /th/ have been acquired. While most children have acquired the ability to make the distinction between the two basic phonological classes, some children have difficulty or seem to have difficulty with phonological consonantal oppositions and vowel oppositions, which might be reflected upon entering school in children's inability to discriminate auditorily one sound from another sound.

After the first phonological opposition, the first consonantal opposition appears. These oral and nasal sounds which appear to acquire a word-differentiating value, (e.g., papa-mama), are followed by the opposition of labials and dentals. These two oppositions, the labial-nasal opposition and the labial-dental opposition form the minimal consonantal system. Until this quadrangular system of consonant oppositions has been established, namely /p/, /t/, /m/, /n/ (Velten, 1943, p. 282), the second vowel, which is either /i/ or /u/, does not appear. As priority of distinction in vowels is according to degree of aperture, the first vowel opposition appears as the broad vowel /a/ becomes opposed to a narrow one /i/. Sometimes as variant of the basic vowel /a/, a narrower and more frontal vowel /e/ appears in the beginning which is either optional or a fluctuation of pronunciation, or combinatory as in a French child usually /a/ after labials and /e/ after dentals. Some children are not immediately able to utter a labial sound before a front vowel. Perhaps these children who have difficulty in uttering a labial sound before a front vowel, are also the children who may have difficulty in discriminating words beginning with a labial sound followed by a front vowel. As soon as both vowels /a/ and /e/ become independent phonemes the child seeks to sharpen the

opposition /e/ to a narrower /i/. With the following step of the child's vowel system which is either a split of the narrow vowels into a palatal and a velar (e.g., papa-pipi-pupu) or a third intermediate degree of openness /e/, the "minimal vowel system" consisting of three vowels is formed.

Both minimal vowel systems are specifically characterized like the minimal consonant system by the existence of phonemes which combine two distinctive qualities. In the basic vowel triangle, /u/ is narrow as opposed to /a/, and velar or rounded as opposed to /i/. In the consonant system which has /m/, /p/, and /t/, /p/ is oral in opposition to nasal /m/ and at the same time labial in opposition to /t/. The general law reads that the concept of the phoneme is not identical in any language with that of the distinctive features; rather it is superposed on it.

In examining acquisitions in the child's consonant or vowel system which exceed those already described, according to Jakobson (1968), it may be seen that there is an astonishing exact correspondence between the temporal order of these acquisitions and the general law of unilateral implication. Thus, the acquisition of fricatives, presupposes the acquisition of stops in child language, and in the linguistic systems of the world, the former cannot exist unless the latter exists as well. Similarly, the opposition of a stop and an affricate in language implies the presence of the fricative of the same series. Likewise, the acquisition of the back consonants implies the acqusition of the front consonants. Therefore, in the acquisition of the nasals and stops the velar nasal /ŋ/ in English is replaced by the child with the dental /n/ and the velar stops are replaced with the corresponding dentals. Thus in the development of the child

language /k/ merges with /t/ and only later does /k/ emerge as an independent phoneme.

The same law of unilateral implication applies to vowels. No opposition of two vowels of the same openness is acquired as long as there is lacking a corresponding opposition in the vowels of narrower openness. The phoneme /æ/, to which are opposed /a/, as the velar counterpart of the same degree of openness, and /e/ as the narrow counterpart, emerges relatively late in the language of the child. Jakobson (1941) and Weir (1962) both point out that the phonemic status of /æ/ is acquired relatively late by the English-speaking child due to the usually earlier acquired contrast of /a/ and /e/. No differentiation by degree of openness can arise in the round vowels so long as the same opposition is lacking in the unrounded vowels. Thus, the pair /u/-/o/ cannot precede the pair /i/-/e/ and there are no children who have an /o/ phoneme without having acquired an /e/ phoneme. Very often /o/ is acquired significantly later than /e/. The existence of a secondary vowel depends on the coexistence of both of the corresponding primary vowels. Among the last phonological acquisitions of the child are oppositions which are comparatively rare such as nasal vowels, or the liquids /l/ and /r/.

Summary

Research studies show that a positive relationship between auditory discrimination and articulation is almost invariably found in children below nine years of age and seldom found above that level. Findings suggest that phoneme development is correlated with age, in that some sounds are produced earlier than others and that most sounds

are correctly produced by eight years of age. Although research studies indicate a sequential development in articulation of speech sounds, no comparable sequence of orderly development is apparent for the auditory discrimination of speech sounds. While the sequence of language development as outlined by Jakobson and Halle (1956) is speculative, and while these generalizations should be regarded as hypotheses rather than facts, it is plausible that a developmental sequence similar to Jakobson and Halle's may be followed in the auditory discrimination of phonemes in the language of the child. Although other linguists speak of innate phonological systems and refer to suppression of phonological rules acquired prior to "first stage of language development", Jakobson and Halle's conceptual framework of distinctive features may serve as a guide for a theoretical framework for research in the sequencing and ordering of phonemes in auditory discrimination development. As Fant has emphasized the importance of the relationship of phonemes in their environments and the effects that one phoneme may have on another, research is also needed to investigate a sequence of development involving fine discrimination of speech sounds.

IV. AUDITORY MEMORY SPAN

Relationship of Auditory Memory to Hearing, Speech and Reading

Before a child can develop a phonetic system by which he can read strange or unfamiliar words he must be able to differentiate the sequence of sounds as well as the spatial pattern of letters in vision (Monroe, 1932). Auditory impressions of words consist not only of sound qualities but also of the temporal distribution of sound in a

pattern. For some children entering school this may be difficult, as the sequence of sounds spoken rapidly appears to be almost simultaneous.

In describing lack of auditory memory as the "failure to remember what is heard," Gray (1922:19) believed that this lack of auditory memory resulted in the inability to remember sounds of words and consequently in confusion or even complete failure in reading. At this time Gray also commented that the small child has often a short concentration span and oral instruction fails to be understood or retained. Almost a decade later, Saunders (1931) stated that the addition of one extra sound in a language pattern is great enough to throw the whole pattern into confusion. Vernon (1962) also considered accurate sequencing of sounds difficult for some school age children.

Other researchers have also considered the importance of these factors of concentration and attention in relation to memory. Both Stauffer (1948) and later Sanstedt (1964) considered memory span specifically as a manifestation of concentration, sustained attention and associability necessary for immediate reproduction. Previous to this, research reported by Blankenship (1938) indicated that the subject must be able to distribute his attention over the series of stimuli and concentrate his attention so that the mental processes may continue in the direction started. Blankenship also contended that research was inconclusive as to whether memory span is a general or a specific ability; but that substantially different spans were secured according to the modality through which the impression was received. He stated that a general ability would operate through different sense organs and he quoted Smedley and Jones' findings (cited by Blankenship,

1938) that a combining of sense organs produced a superior memory span with the following order of strength of span: (1) combined audito-visual-articulatory, (2) audito-visual-hand-motor, (3) visual, (4) audito.

In an effort to ascertain whether the memory span factor transcends to modality of the sense organ, Karlin (1942) resolved Blankenship's (1938) dilemma by finding that auditory memory span has both general intellectual and specific auditory components. Karlin stated that the span increased through maturation and was temporarily improved through instruction. Blankenship (1938) had reported coefficients of correlation for auditory memory span and intelligence varying from .03 to .65 for forward span and even greater coefficients for reverse span. Insofar as a general factor is concerned, Poling (1968) felt that auditory memory span was intellectual, but that it also had specific auditory aspects. She hypothesized that the sound impression was the auditory aspect of auditory memory span and the temporal distribution was the intellectual aspect.

With respect to the maturational factor of memory span as suggested by Karlin, Vernon (1959), in reference to findings of Piaget and Inhelder (1956), showed that young children do not readily perceive order, and stated that even when children have learned which letters belong to a word they may not remember what their order should be. Vernon (1959) explained that this is not necessarily peculiar to cases of backwardness or physical defects, but it is a feature of the immature type of perception which tends to occur generally in beginners and persists longer in backward than in normal readers. Therefore, a child of eight or nine may still have difficulty in auditory

sequencing of sounds.

Raymond (1955), in summarizing previous investigations of memory span, noted that the length of span for any one individual varied according to the materials used in the tests, and that memory span increased with chronological age and intellectual ability. Of the forty studies reviewed only four had considered memory span in relation to reading ability. From her own study Raymond (1955) concluded that reading achievers make significantly higher scores on memory span tests of related-verbal items (sentences) than on memory span tests of unrelated verbal items (words) and non-verbal items when the presentation is auditory.

Anderson (1939) used isolated speech sounds for materials to measure memory span. Although Anderson did not correlate the results of his tests with those measuring success in reading, some of his findings are perhaps significant and might possibly be related to reading and auditory perception. Among his conclusions he indicated that speech sounds, and especially vowel sounds, were highly desirable materials for a test of auditory memory span. It is interesting to note that the subjects for Anderson's study were students from the University of Wisconsin. After a semester of phonetic training, test results indicated that auditory memory span for vowel sounds was relatively independent of phonetic training. In the case of the consonant test, training tended to improve performance but not proportionally for all members of a group. This finding probably indicates that there is not only a difference in auditory memory span for vowels and consonants, but it may also suggest the problem of differentiating the auditory factors of memory and discrimination. That is, students

may not be able to remember because they are unable to discriminate. Metraux (1944) reported that the auditory memory span for vowels increases to age ten, whereas memory span for consonants increases to age twelve. She indicated as well that consonants might be more difficult to distinguish and remember than vowels.

Little attempt has been made to measure the memory spans of pre-school and primary children in spite of the wide variety of subjects which have been tested (Poling, 1968). Much of the research reported seems to be related to children who apparently have physical disabilities such as minimal cerebral dysfunction, hearing and speech defects or who are so-called retarded readers. For example, Orton (1937), referring to children with speech and reading problems arising from suspected organic disturbances, commented three decades ago that it is the recall of sounds in proper temporal sequence which seems to be at fault. Hardy (1966) proposed that the fundamental language disability of children with suspected or actual neurological impairment may be their difficulty in properly ordering acoustic events. In evaluating auditory perception of children with minimal or mild cerebral dysfunction, Aten and Davis (1968) concluded that temporal ordering difficulties and reduced attention are seen to contribute to psycho-linguistic problems in language learning.

Researchers such as Bond (1935), Rizzo (1939), and Rodgers (1966) have attempted to find the relationship between performance on auditory memory span tests of groups of achieving and groups of non-achieving readers. Results of studies indicated that the probability of holding a sequence in mind and operating upon its component parts, entails a general cognitive ability which measures more than auditory

memory span. Betts (1957:126) pointed out that memory span is a significant factor in readiness for beginning reading, as a short auditory memory span is reflected in an inability to master word recognition techniques. Eagan (1970), from her review of related literature, concluded that if reading is being taught by a look-and-say method, then auditory memory span would seem to be even more important than other methods of teaching which might be employed. If this is so and if Wepman's theory of auditory perception is correct, it would seem then that auditory discrimination ability is fundamental to a look-and-say method, as well as to a phonics method of teaching reading.

Summary

While research suggests a positive relationship between auditory memory span and reading achievement, findings are inconclusive. Poling (1968) stressed the importance of evolving valid tests to determine the magnitude of memory span crucial to reading and to study with greater effectiveness the relationship of auditory memory span to reading and other factors. As much of the research reported in relation to auditory memory span seems to be related to children with apparent physical disabilities, there is need for research to determine memory spans of normal pre-school and primary school children in relation to auditory discrimination and beginning reading.

V. THEORETICAL MODEL

The difficulty of a phonetic measurement of hearing in relation to reading is that it necessarily involves the use of spoken language if precise information is to be obtained about the mechanisms

of auditory identification. The method of sampling, therefore, has to be based on speech, conform to linguistic laws and correspond to a unit of auditory identification. The choice for investigation in this research was the phoneme in relation to other phonemes. Accepting the explanation that the smallest unchanging neurophysiological unit must have a larger domain, perhaps the size of a syllable (Ladefoged, 1967) and "that the type of sound, position of sound, voicing and environment of the phoneme all play a part in the discriminability of a particular speech sound," (Fast, 1968:121) the following theoretical model was developed to indicate the relative impact the environment of the phoneme may have in the acquisition of language, and more specifically in the discrimination of sounds and their relation to beginning reading.

Underlying the model and basic to the developmental process of hearing with respect to the acquisition of language and its relationship to the process of reading are four levels: an acoustic-physiological level, a neuro-physiological level, a psycho-physiological level and a linguistic level. At the acoustic-physiological level the sound received causes acoustic vibrations which stimulate the basilar membrane to excite impulses in the nerve fibers that innervate the hair cells of the Organ of Corti. As the integration function is established, the first process involved is neurophysiological in nature. At this stage the reticular system which seems to be responsible for a general over-all activating function in the nervous system may inhibit or facilitate the auditory transmission of sensory message to the brain very early in the path of the transmission. Closely related to the neuro-physiological level, is the psycho-physiological

level. The psycho-physiological level, implying a certain amount of learning, experience and previous knowledge, is based on intelligence and related factors of attention, interest and motivation. Recognition of the message occurs at the linguistic level and is based on powers of abstraction.

Fundamental to these four basic levels is the acoustic environment as it is only through experience involving consistent exposure to particular auditory stimuli that the child learns to attend to and to be aware of sounds, to discriminate fine differences in speech sound, and to retain and to recall them. This facilitates the phonological development so necessary in the acquisition of language, in accuracy of articulation and in the process of recoding, decoding and encoding in reading.

By means of a hypothetical triangle, with auditory acuity at its base, the sequential development and interrelationships among auditory comprehension, discrimination and memory are indicated with their dependence upon maturation, experience and learning. As the child in learning to read relies heavily upon his ability to associate the sound symbol with the graphic symbol, the relationship of hearing to reading is shown through the process of recoding the grapheme to the phoneme and of decoding for meaning. By identifying the words correctly the child is then able to comprehend and assimilate the ideas conveyed by the word. Underlying the process of word perception is the ability to discriminate auditorily differences between sounds. As it appears that a consonant cannot be uttered in isolation, it would seem that the phonemic environment of that consonant would determine to some degree the auditory discrimination of the consonant.

This study posed pertinent questions and sought answers to determine which linguistic features of consonants and vowels enhance the phonemic environment of stop and nasal sounds to aid in auditory discrimination. To appraise the model (see Figure 2.1), testing began with assessing the ability of the child to hear sounds within the normal range of acuity, followed by an assessment of ability to discriminate particular sequences of phonemes and ability to retain and to recall accurately sequences of phonemes. In addition, results of auditory tests were related to the word recognition and comprehension ability of the child to determine if auditory discrimination facilitates or inhibits reading ability.

Summary

This chapter reviewed research studies concerning the interrelationships of hearing and speech to beginning reading. A model was devised to illustrate developmental aspects and interrelationships among auditory abilities and their relation to beginning reading through the sequential processes involved in the acquisition of language. The model was appraised by the present study. To investigate the ease or difficulty of perception of particular sequences of phonemes and their relation to other auditory abilities, as well as the importance of maturation and learning to their development, an auditory discrimination test was constructed. The following chapter will discuss the theoretical background and construction of the research instrument.

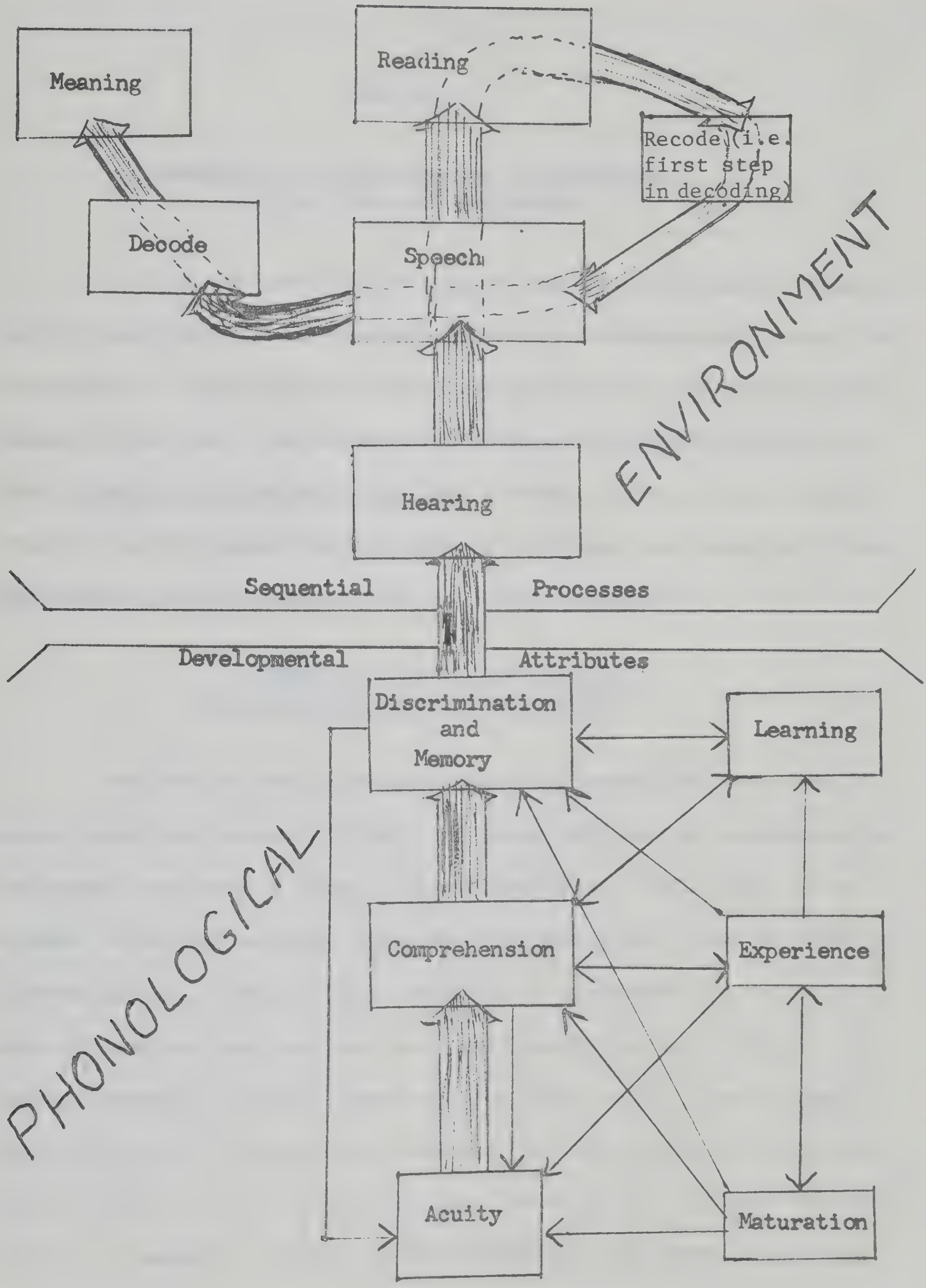


Figure 2.1

Model of Phonological Environment

CHAPTER 3

THEORETICAL BACKGROUND AND CONSTRUCTION OF THE RESEARCH INSTRUMENT

To test the questions raised in the previous chapter concerning phonemic decision processing, an auditory discrimination test was constructed. This chapter reviews the theoretical background of the research instrument and describes the construction of test items for the S-N Auditory Discrimination Test. Results of the Pilot Study in relation to the administration, initial findings and revision of the S-N Auditory Discrimination Test are also discussed.

I. THEORETICAL BACKGROUND OF THE S-N AUDITORY DISCRIMINATION TEST

Few studies have been undertaken to investigate features of sounds which may cause difficulty to young children in discriminating one sound from another sound. Miller and Nicely (1955:338), in an attempt to determine which features of phonemes were used as cues for discrimination, confined their analysis to consonants in the initial position and did not consider vowels. From Miller and Nicely's evidence, Olmsted (1966:533) theorized that there will be more errors based on place of articulation than on friction or duration and more errors based on place of articulation, friction and duration than on voicing or nasality. Based on the assumption that there is a close relationship between articulation and discrimination of speech sounds,

Olmsted (1966) predicted that the most discriminable sounds are learned earlier than the less discriminable ones. If Olmsted's (1966:531) prediction that "learning as measured by correct pronunciation is a function of ease of perception of sounds," it would seem that stop and nasal sounds which, according to Templin (1957) are articulated correctly at an early age, should be the easiest sounds for children coming to school to discriminate auditorily. Results of recent studies (Cosens, 1968; Fast, 1968; Oberg, 1970; and Eagan, 1970) have indicated that stop and nasal sounds are among the most difficult sounds for children to discriminate during early school years.

In investigating developmental aspects of auditory discrimination in relation to reading, Fast and Cosens (1968) devised a word-pairs test. Examination of the sound contrasts in Cosens' study (1968:117) suggested that sounds articulated near the front of the mouth presented a problem. Furthermore, studies of Oberg (1970), Eagan (1970) and Cosens (1968) also revealed that not only sounds articulated near the front of the mouth presented problems but comparisons between sound contrasts articulated at the front and back of the mouth as well as at the center and back of the mouth presented a problem. Cosens (1968:115) suggested the importance of transition cues in the auditory discrimination of sounds. Previous experiments dealing with consonant perception conducted by researchers at Haskins' Laboratories (Delattre, Liberman and Cooper, 1955) have indicated that the transition from the consonant to the vowel is an important cue to the recognition of stop sounds. Rudegeair (1970) postulated that two contrasting stop sounds should be more confusing in a context where they exhibit highly similar transition patterns than in another context

where their transitions are dissimilar.

Eagan (1970), using the Fast-Cosens Auditory Discrimination Test examined scores on word-pair items necessitating the use of various articulators and points of articulation. Eagan's (1970) findings substantiated those of previous investigators (Cosens, 1968:109 and Oberg, 1970:79) in that glides and laterals were among the least difficult sound contrasts to discriminate, and stop and nasal contrasts involving bilabial-velar comparisons and alveolar-velar comparisons were among the most difficult. Eagan (1970) noted that the stops which created the most difficulty were voiceless stops /p/ - /k/ in final position and voiced stops /b/ - /g/ in final position. Eagan (1970:86) concluded that students experience undue difficulty when sound comparisons are made between front and back sounds and she hypothesized that the further away the points of articulation are from each other the more difficult it is to discriminate the sounds. Although this may be true, the fact that sometimes these comparisons are discriminated correctly may indicate the importance of the environment in which the sound is perceived. This difficulty encountered in identifying plosives or stops in speech has been studied by Denes and Pinson (1968:131). In their experiment Denes and Pinson (1963) presented a group of listeners with test syllables consisting of stops "centered" at a number of frequencies and a vowel. The experimenters reported:

> No single plosive burst was consistently heard as the same plosive consonant. For example, a plosive burst centered at one frequency was heard as a /k/ when associated with one vowel and as a /p/ when associated with another vowel. In other words, the kinds of plosive consonant we hear depends not only on the

> frequency of the plosive burst, but also on the nature of the following vowel (Denes and Pinson, 1968:132).

Since it is known that the nature of the following vowel does affect the frequency of the burst, it is quite possible that this in turn affects discrimination performance.

Although Moffatt (1970) did not conduct a study to examine vowel sounds specifically in relation to plosives, he did attempt to examine the ability of Kindergarten children to discriminate vowel sounds or what he termed syllable nuclei speech sounds. Contrary to previous thought, Moffatt (1970) reported that Kindergarten children have not mastered the ability to make auditory discriminations between all syllable nuclei speech sounds. As in studies previously mentioned investigating developmental aspects of consonants in relation to specific sound features, Moffatt (1970) noted that the important factors in Kindergarten children's auditory discrimination ability of nuclei speech sounds appears to be the place of articulation, the position of the sound in the word, the length of the syllable nuclei speech sound, the location of the stress in the word and the phonological environment of the syllable nucleus in the word being examined. Moffatt concluded that these factors may operate separately or in combination to affect discrimination of speech sounds. Thus, it appears that although distinctive features of consonant and vowel sounds are important in the discrimination of sounds, another important factor in discrimination seems to be the relationship of one sound to another sound and the effect that these sounds have on one another.

Summary

Findings from recent research studies investigating the

auditory discrimination ability of young children suggest the progressive ability of children to make auditory discriminations of specific sound contrasts (Cosens, 1968; Oberg, 1970; and Eagan, 1970). An important factor in the auditory discrimination of sounds appears to be the ability a child has to discriminate the same phoneme in different environments. The child beginning reading, who is unable to discriminate sounds in a particular environment, may have difficulty in associating sounds with symbols. This leads to the importance of recognizing progressions that may exist in children's ability to discriminate sounds and to implement findings in the formal training of auditory discrimination of young children. It remains then to determine the environments in which stop and nasal sounds may prove difficult or easy for young children to discriminate.

Relationship of Stops and Nasals to Syllable Nuclei in Their Environment

As the importance of the environment of the consonant has been suggested in discriminating one phoneme from another, the question arises as to the number of significant units which may be relevant to the recognition of stops and nasal sounds and which thereby would aid in the discrimination of these phonemes. Usually recognition of speech is accomplished by combining acoustic, linguistic and circumstantial cues (Denes, 1968:146). However, when speech sounds pronounced as isolated monosyllabic words are to be recognized, it is more complicated as neither the context nor the situation aids the listener in the task of discrimination. Therefore, a word deprived of any prompting context either verbal or non-verbal can be recognized by the listener only through its sound shape.

With special reference to variance attributable to articulatory characteristics of consonants, House and Fairbanks (1953:113) noted that the consonant environment significantly influenced acoustical measurements of the duration, fundamental frequency, and intensity of the vowel preceded and followed by the same consonant. It was observed that vowels in voiced environments were in general longer in duration, lower in fundamental frequency and greater in relative power than voiceless ones. Less important consonant characteristics appeared to be manner of production and place of articulation.

Previous to House and Fairbank's study (1953), Licklider and Miller (1951) had noted that adjacent sounds interact and that spectograms of some consonants are considerably modified by the vowels that precede or follow them. Because of this vowel environment, consonants produced in the back of the mouth tend to be more affected by the position of the vocal cavities than consonants produced in the front of the mouth. Furthermore, on the acoustic level in the case of voiceless stop consonants, Gimson (1962) claimed that the vowel transition between the noise and the steady stage of the vowel may be of prime importance for recognition of consonant sounds. It would appear then that besides notable physiological differences, acoustical elements, which tend to merge features of units, may linguistically be treated separately in the recognition of consonants. Fujimura (1962) noted that there is no doubt that the formant transition of the adjacent vowels often plays an important or even dominant role in the recognition of the individual nasal sounds.

While the production and perception of stop consonants have been studied extensively, and important cues for perceptual

categorization of stop consonants have been determined by investigators such as Cooper (1952), Liberman (1954), Delattre (1955) and others, rules formulated from results of these studies have since proven to be more successful in some contexts than in others. That is, the conclusion of investigators that formant transitions are the main cues for voiced stops, and noise burst frequency for voiceless stops is only partially true. Ainsworth (1968), in analyzing data from a perception experiment investigating the importance of various acoustic features for the perception of stops in front of each of twelve English vowels, noted that when the voiced stop /d/ preceded a back vowel the formant transition appeared to be the important cue, but when it preceded a front vowel, the frequency of the noise burst appeared to be the most important. Ainsworth (1968) concluded the most important limitation appeared to be the time constant of the transitions which should be longer for velar stops than for bilabial and alveolar ones. Results of this study indicate that there are certain limitations with respect to the perception of stop consonants preceding each of the English vowels. In other words, the kind of plosive consonant heard depends not only on the frequency of the plosive burst, but also on the nature of the following vowel.

While Peterson and Lehiste (1960:702) found the influence of the initial consonant upon the duration of the syllable nuclei to be negligible, they also found that the duration of syllable nuclei to be significantly affected by the nature of the following consonant. Contrary to what would be expected from anticipated physiological effort, vowels preceding nasals were considerably shorter than those preceding voiced fricatives and only slightly longer than those

preceding voiced stops. As previously stated, sounds of language may be distinguished from one another not only by qualitative differences but also by their duration. Jones (1967:53) seems to verify this effect of duration upon consonants when he asserts there is no doubt that in some sequences the length of the vowel contributes more to the distinction than the qualities of the consonants do. It may be concluded that the distinction between final consonants such as /b/ - /d/ or /p/ - /t/ in terminal position may be strengthened by a difference in the length of the preceding vowel sound. That is, as the duration of a vowel depends on the extent of the movement of the speech organs from vowel position to the position of the following consonant, vowels preceding bilabials /b/ and /p/ are shorter than those preceding the alveolars /d/ and /t/. Therefore, the /I/ in "bib" is shorter in duration than the /I/ in "bid" and the /I/ in "pip" shorter than the /I/ in "pit".

As a result of an attempt by Sharf (1964:89) to determine the effect whispering would have on vowel duration, the elimination of the physiological factor affecting vowel duration served to emphasize the linguistic factor. That is, with the voiced-voiceless consonant contrast eliminated, the durational differential of the vowels remained as the primary distinguishing factor between consonants. Sharf (1964) concluded that while results of the study do not necessarily rule out physiological influences as a precipitating factor, results appear to support the assumption that linguistic structure is at least a perpetuating factor in producing vowel duration variations.

Summary

As it has generally been assumed that greater effort is involved in the production of voiceless consonants than in the production of voiced consonants, vowel duration has to some extent been determined by the physiological effort required to produce the following consonant. Studies have shown that vowel duration may also be linguistically determined and act as an additional clue in distinguishing voiced and voiceless consonants. It may be assumed that these vowel duration variations which aid in the perception of consonants may be learned as a part of the language structure. It is possible that children who have not learned to use this phonemic distinction to discriminate words would also have difficulty with the fundamental process of decoding in reading. While a child may be able to decode the graphic symbols of the word, he may not be able to use anticipatory phonemic distinctions which would aid in the decoding of symbols and in the fusing of sounds for meaning. Thus, the overlapping of vowels and consonants would also suggest that an analysis of speech and an analysis of auditory discrimination should be based on units larger than the sound segment. In order to investigate the foregoing assumptions that the auditory discrimination of stop and nasal sounds depends upon the preceding or following vowel, an auditory discrimination test involving stop and nasal sounds in specific vowel environments was constructed.

II. CONSTRUCTION OF THE S-N AUDITORY DISCRIMINATION TEST

It has been hypothesized that the phonemic environment of the

consonant in relation to the immediate vowel may be the important factor in the auditory discrimination of stop and nasal sounds. Based on the research and findings of studies previously mentioned in this chapter, an auditory discrimination test was constructed to determine whether specific phonemic elements of sounds, namely, place of articulation, manner of articulation and duration, facilitate or inhibit the discriminability of stop and nasal sounds.

Criteria for the Choice of Items

Comparatively little evidence is available concerning the developmental aspects of auditory discrimination of speech sounds. Because recent studies by Cosens (1968) and Oberg (1970) suggested that stops and nasals were difficult to discriminate by some children in their beginning years of school, items on the S-N Auditory Discrimination Test were limited to stop and nasal sounds followed or preceded by a simple vowel. Based on the research findings of Miller and Nicely (1955), no items were included in the test which required discrimination between voiced or voiceless sounds or between nasal and non-nasal sounds. Items chosen, therefore, required discrimination of sounds in relation to place of articulation and duration. The following sections will discuss the major criteria for choice of test items:

(1) position of sounds in words;

(2) selection of sound contrasts; and

(3) selection of word controls.

Task Differentiation

Position of sounds. In the construction of the S-N Auditory Discrimination Test consideration was given to stop and nasal sounds

following or preceding simple vowel sounds in all conceivable combinations of sequences of sounds common to the English language. As it is a moot question whether the medial position for a consonant sound actually exists, and as some linguists look at consonants simply as methods of approaching or terminating vowel sounds, no comparisons were made between consonant sounds in medial position. In this study comparison of stop and nasal sounds was limited to initial and final position.

Sound Contrasts. As it has been hypothesized that place of articulation and duration act in English as additional cues in distinguishing voiced and voiceless consonant sounds and nasal sounds, test items were chosen bearing in mind the influence that a consonant may have on the duration of the vowel and the intrinsic duration of both the vowel and the consonant as determined by its phonetic quality.

Studies by Peterson and Lehiste (1960) and House (1953) and Halle and Stevens (1967) of the duration of vowel sounds in American English have shown that vowels are longer before voiced consonants than before voiceless consonants. Peterson and Lehiste (1960) noted vowels preceding nasals are slightly longer than those preceding voiced stops. Duration of nasals found during the Peterson and Lehiste study are at variance with the measurements presented by Halle and Stevens (1967). Halle and Stevens argue that the wide separation of the vocal folds during voiceless consonants, which is more rapid than the more finely adjusted smaller separation for voiced consonants, explains the shorter duration of vowels before voiceless consonants than before voiced consonants. The shorter duration of vowels before nasals than before voiced plosives is due to the special adjustment of the vocal

folds which is needed to maintain vibrations during voiced plosives. No such adjustment is needed for voiced pasals.

The intrinsic duration of the vowel appears to be correlated with tongue height and degree of aperture; a high vowel then is shorter than a low vowel and a tense vowel is longer than a lax vowel. Simple vowels can be grouped according to four degrees of length: long - /æ, ɔ, ɒ/; relatively long - /e, o/; relatively short - /i, u/; and short /I, ɛ, ə, ʊ/ (Peterson and Lehiste (1960), Heffner (1937), House and Fairbanks (1953). On the foregoing premises, in the placement of vowels in the construction of the test items, consideration was given to tongue height and tongue position. Figure 3.1 indicates the tongue height and tongue position of the vowel phonemes to be used in the research instrument. As shown in Figure 3.1, the position of the tongue varies in two dimensions. While it may be relatively high, mid or low, it may be also relatively front, central or back. Therefore, the /i/ in "beat" is considered as a high front vowel and the /o/ in "boat" is referred to as a mid back vowel.

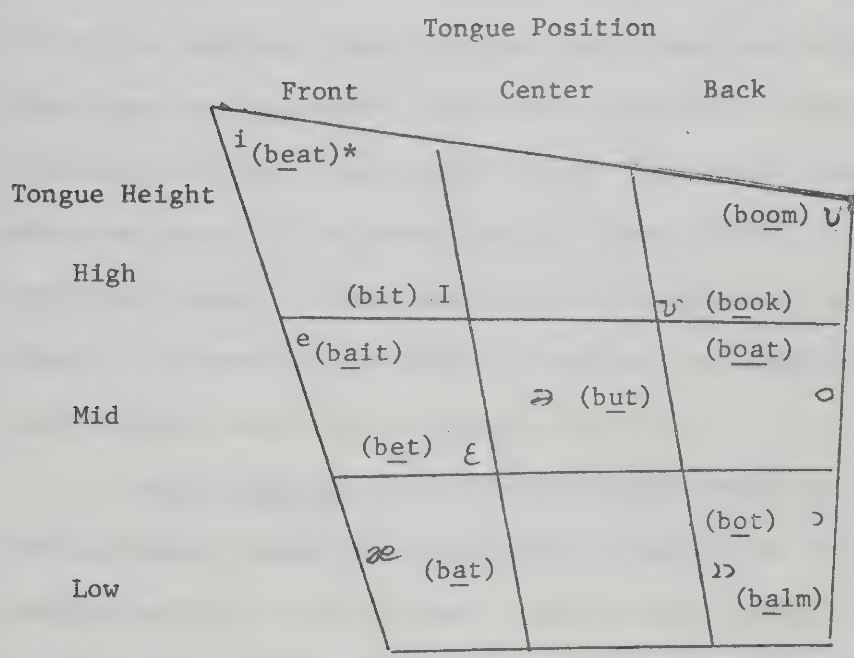
As already mentioned, the type of consonant sounds in the study is limited to the voiced and voiceless stop sounds /b, d, g/ and /p, t, k/ and the nasal sounds /m, n, ŋ/. Table 3.1 shows the relative position of stop and nasal sounds in relation to the common phonemes found in the English language. The intrinsic duration of consonants is influenced by their point of articulation. Most investigators agree that bilabials are longer than alveolars and velars. While there is some agreement concerning the labial point of articulation, Lehiste (1970) indicated that the relative order of the durations of alveolars and velars seem to vary with position or with language.

TABLE 3.1

ENGLISH CONSONANT PHONEMES*

Type of Sound		Bilabial	Labio dental	Inter dental	Alveolar	Alveo palatal	Velar	Glottal
Stops	vl.	p			t		k	
	vd.	b			d		g	
Fricatives	vl.		f		s	š		
	vd.		v		z	ž		h
Affricates	vl.					č ǰ		
Nasals		m			n		ŋ	
Lateral					l			
Glides		w			r	y		

* Gleason, 1961:24



*(-) grapheme representation

Figure 3.1

English Vowel Phonemes

Items included in the research instrument involved the following consonant sounds: bilabial-bilabial, alveolar-alveolar, velar-velar, bilabial-alveolar, alveolar-velar, and bilabial-velar. While manner of articulation is not considered per se in this study, and while there are few studies concerning the relationship of the manner of articulation of a consonant in relation to the duration of a consonant sound, Lehiste (1970) noted that Falc'hun had found that after a stressed vowel, a nasal was shorter than a voiced plosive and a voiceless plosive longer than a voiced plosive. With the previous statements in mind, it is possible to hypothesize that in the final analysis a child may interpret the duration of a particular sound by relating it to the duration of the word as a whole. Figure 3.2 shows the placement of the consonant sounds in relation to the simple vowel sounds and the comparisons to be made in this study. As indicated in Figure 3.2 in the auditory discrimination test there are minimal word-pair items such as "peat-peak" containing the initial voiceless stop /p/ preceding the high front vowel /i/ and "keep-peep" containing the final voiceless stop /p/ following the high front vowel /i/. It may also be seen from Figure 3.2 that some sounds are omitted from the test. For example, as expected in English, there are no word-pair items containing the velar nasal /ŋ/ in initial position.

Word controls. It has been noted by Malmberg (1963:196) that certain speech sounds in a word can be regarded as the cue to its identification. That is, when a word is long, such as "grandfather", speech sounds may be lost without preventing the correct identification of the word. Therefore, the shorter the words the more characteristic the speech sounds. It was concluded then that words in the test should

CONSONANTS	VOWELS										
	Front					Center	Back				
	i	ɪ	e	ɛ	æ	ə	u	ʊ	o	ɔ	ɒ
Stops vl. P	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌞		⌝ ⌞	⌝ ⌞	⌝
T	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌞	⌝ ⌞	⌝ ⌞	
K	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝
vd. B	⌝	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝	⌝	⌝	⌝ ⌞	⌝
D	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌞	⌝ ⌞	⌝ ⌞	
G		⌝ ⌞	⌝	⌝ ⌞	⌝ ⌞	⌝ ⌞			⌝	⌝ ⌞	
Nasals M	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞		⌝ ⌞	⌝ ⌞	⌞
N	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞	⌝ ⌞		⌝ ⌞	⌝ ⌞	
NG		⌞			⌞	⌞				⌞	
	High		Mid		Low	Mid	High		Mid	Low	

Key: ⌝ initial consonant comparison made in words, i.e. <u>C</u>VC

⌞ final consonant comparison made in words, i.e. CV<u>C</u>

Figure 3.2

Placement of Consonant Sounds in
Relation to Vowel Sounds

be as short as possible. While words of two phonemes common in the spoken language would be best for this purpose, the choice of phonetic juxtapositions would not be sufficient with two phonemes. That is, to investigate the sound contrast /b/-/d/ preceding or following the high front vowel /i/ only two test items, one for each sound contrast, could be constructed "be-de" and "eb-ed". Therefore, it was decided to use three-phoneme words of the consonant-vowel-consonant type. As indicated in Figure 3.2, as many monosyllabic words as possible were constructed using juxtapositions of /p, t, k/, /b, d, g/ and /m, n, ŋ/ in the environment of simple vowels. All constructed words were checked for availability. Although many of the monosyllabic words were unfamiliar to the child, no word was included in the test which did not exist in the English language, having words unfamiliar to the child helped, to a certain extent, to eliminate the semantic factor of the child's discriminating word-pair items by meaning rather than by sound. The World Book Dictionary (1967) was used as the authority to verify the existence of the monosyllabic word in the English language. The Gage Dictionary of Canadian English, the Beginning Dictionary was used as the authority on pronunciation to determine whether or not test items containing the monosyllabic word contrasts were actual minimal pairs.

As Fast and Cosens (1968) based their word-pair test on the supposition that the low correlations between auditory discrimination and reading using the Wepman Auditory Discrimination Test might not discriminate between subjects with good and poor auditory discrimination every fifth item from Form B of the Wepman Auditory Discrimination Test to test this supposition was included in the initial form of the

S-N Auditory Discrimination Test. Besides including 8 word-pair items from the Wepman Auditory Discrimination Test, the 15 items reported by Oberg (1970) as being the most difficult word-pair items for primary children to discriminate on the Fast-Cosens Auditory Discrimination Test were also included in the initial test. The initial form of the S-N Auditory Discrimination Test consisted of 425 minimal word-pair items, 75 like word-pairs and 350 unlike word-pairs. As the test was constructed to determine difficulty of stop and nasal sounds in specified environments, every monosyllabic unlike word-pair constructed was included in the initial form of the test. Therefore, as the test was long, like word-pair items were limited in the original test particularly to sound contrasts less common in the English language as in the word-pair item "gean-gean" which contains a /g/ preceding the high front vowel /i/. Table 3.2 shows the number and type of sound contrasts included in the test. Like Figure 3.2 it may be observed from Table 3.2 that some stop and nasal sound contrasts in the English language are more common than others. Table 3.2 shows the number and type of sound contrasts included in the initial form of the auditory discrimination test. For example, the $\boxed{8}$ indicates that there are eight minimal word-pair items containing the initial voiceless bilabial stop /p/ preceding a high front vowel.

Validity

The S-N Auditory Discrimination Test was constructed by the investigator because it was impossible to secure a standardized or nonstandardized auditory discrimination test for the purposes of this research study. The validity of the test is dependent upon the definition

TABLE 3.2

NUMBER OF SOUND CONTRASTS CONTAINED IN MINIMAL WORD-PAIR ITEMS OF INITIAL AUDITORY DISCRIMINATION TEST

CONSONANTS	VOWELS														
	High Front		Mid Front		Low Front		Center		High Back		Mid Back		Low Back		
	I*	F**	I	F	I	F	I	F	I	F	I	F	I	F	
Bilabials															
voiceless /p/	$\boxed{8}$	6	5	3	5	4	4	2	1	2	3	4	5	3	
voiced /b/	10	5	6	2	5	4	5	3	3	1	0	0	6	5	
nasal /m/	6	2	4	3	6	4	4	2	1	2	2	5	5	3	
Alveolar															
voiceless /t/	5	6	5	8	6	4	4	5	2	2	5	6	3	5	
voiced /d/	8	8	4	6	5	7	6	0	2	3	2	6	3	5	
nasal /n/	7	11	2	11	5	5	2	2	1	9	2	4	5	4	
Velar															
voiceless /k/	4	6	4	6	5	4	4	4	1	3	6	4	7	5	
voiced /g/	5	5	4	6	4	5	2	5	2	0	1	0	2	8	
nasal /ŋ/	0	4	0	1	0	1	0	0	0	0	0	0	0	4	
Bilabial-Alveolar															
voiceless /p/-/t/	5	4	3	2	5	6	5	3	1	0	3	4	5	3	
voiced /b/-/d/	9	5	6	1	4	4	2	2	2	0	1	0	5	4	
nasal /m/-/n/	3	6	2	6	5	5	2	5	2	4	4	3	4	1	
Alveolar-Velar															
voiceless /t/-/k/	5	3	8	5	5	5	1	3	3	0	6	2	4	5	
voiced /d/-/g/	4	4	5	2	3	3	1	3	2	0	2	0	5	4	
nasal /n/-/ŋ/	0	5	0	0	0	2	0	2	0	0	0	0	0	2	
Velar-Bilabial															
voiceless /k/-/p/	6	5	3	3	5	3	3	1	2	0	4	5	6	3	
voiced /g/-/b/	5	5	4	0	3	4	1	4	10	0	2	0	4	5	
nasal /ŋ/-/m/	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
Total	90		65		71		46		26		43		69		410
Fast-Cosens - Wepman															15

*Initial **Final

for auditory discrimination. All minimal word-pair items, therefore, required hearing fine differentiations of stop or nasal sounds. As stop and nasal sounds are considered to be middle frequency tones having between 1400 and 3200 double vibrations per second, test items required hearing the differences between a pair of phonemes within the same frequency level as well as within the environment of the same vowel sound. In using these speech sounds, the test also included varying degrees of discrimination from gross to fine. Choice of test items was also based on research evidence of Miller and Nicely (1955), Cosens (1968) and Oberg (1970).

III. THE PILOT STUDY

The initial form of the research instrument was administered to 12 children from a private Kindergarten class in the city of Edmonton. To avoid the practice and learning effect that might possibly occur during the administration of a long test, the test was divided into nine subtests, eight subtests containing 50 items and one test containing 25 items. As the nine subtests were administered individually by the investigator to each child in rotating order, no 2 children were administered the test in the same sequence. Owing to illness, 3 children in the pilot study were unable to complete the test within the testing period. Therefore, the interpretation of test results was based on total scores of only 9 children.

Results of this initial administration of the auditory subtests enabled the investigator to make necessary refinements in the administration and scoring procedures of the tests, to apply and to examine the statistical analysis of the test, to determine by

statistical analysis which items discriminated between subjects with good auditory discrimination and those with poor auditory discrimination, and to refine and shorten the auditory discrimination test by deleting word-pair items.

To obtain objective means for evaluating the auditory test, results of the pilot study were subjected to a Test Item Analysis computer program processed by the Division of Educational Research Services at the University of Alberta. Results of this program yielded a difficulty index, a biserial correlation and a reliability index. The difficulty index and the biserial correlation were used as criteria to determine whether or not an item should remain in the revised test.

The difficulty index indicated the proportion of subjects who made a correct response to a particular item. As the study was attempting to determine types of phonemic contrasts children find difficult to discriminate, no basal level was set to eliminate difficult items. To eliminate easy test items as well as to shorten the test, an attempt was made to remove all items with difficulty indexes of .88 or more. From Table 3.3 it may be seen that 160 items fell outside this difficulty range. The majority of items within the difficulty range .88 to 1.0 were like word-pair items and word-pair items containing phonemic contrasts in initial position. Items which fell within the desired difficulty index range .00 to .88 were screened according to their biserial correlation. The biserial correlation, an index of item validity, gave the correlation of the test item with the total test. Forty-four items with no correlations or minus biserial correlations were eliminated from the final version of the test. As a result of these two criteria, the level of difficulty and the biserial

correlation, 204 word-pair items were to be omitted from the auditory test. However, some eliminated word-pair items were retained in the revised test, as it was considered desirable to have each phonemic contrast represented. Twenty-nine minimal word-pair items retained in the revised test were, therefore, relatively easy.

TABLE 3.3

DISTRIBUTION OF TEST ITEMS ACCORDING TO DIFFICULTY INDEXES

	Number of Difficulty Indexes From:									
	.00 to .110	.111 to .221	.222 to .332	.333 to .443	.444 to .554	.555 to .665	.666 to .776	.777 to .887	.888 to .998	.999 to 1.000
Initial Form	3	2	7	15	27	46	69	96	104	56
Revised Form	3	2	5	12	20	42	54	83	29	0

The revised form of the S-N Auditory Discrimination Test consisted of 250 items, 61 like word-pairs and 189 unlike word-pairs. Table 3.4 gives an analysis of sound contrasts contained in word-pair items in the revised form of the test. While items in the initial test were arranged in random order, some items in the final test were retained in the order designed randomly in the initial test. Items from the last four tests were brought forward systematically to replace eliminated word-pairs in the first test and subsequent tests. The final test consisting of five subtests containing 50 word-pair items is included with directions for administration in Appendix B. Word-pair items arranged according to sound contrasts examined are also

TABLE 3.4

NUMBER OF SOUND CONTRASTS CONTAINED IN MINIMAL WORD-PAIR ITEMS OF REVISED AUDITORY DISCRIMINATION TEST

CONSONANTS		VOWELS High Front		Mid Front		Low Front		Center		High Back		Mid Back		Low Back		
		I*	F**	I	F	I	F	I	F	I	F	I	F	I	F	
Bilabials																
voiceless	/p/	8	2	3	1	2	2	3	1	1	2	2	2	5	1	
voiced	/b/	7	2	5	1	3	3	4	1	2	1	0	0	6	3	
nasal	/m/	2	0	4	2	4	2	3	1	1	1	1	1	3	4	
Alveolar																
voiceless	/t/	3	4	4	4	5	0	3	4	2	2	5	4	3	1	
voiced	/d/	3	4	3	4	3	2	3	0	1	4	1	4	2	2	
nasal	/n/	1	6	3	6	4	4	2	0	1	4	1	1	5	3	
Velar																
voiceless	/k/	2	3	2	4	3	0	3	3	2	2	5	3	5	1	
voiced	/g/	5	2	2	3	3	4	1	5	1	0	0	0	2	4	
nasal	/ŋ/	0	2	0	0	0	1	0	0	0	0	0	0	0	2	
Bilabial-Alveolar																
voiceless	/p/-/t/	1	3	0	1	3	5	3	1	0	0	1	1	2	2	
voiced	/b/-/d/	4	2	4	0	2	3	1	2	0	0	1	0	2	3	
nasal	/m/-/n/	3	3	1	6	2	5	2	2	2	2	2	3	3	1	
Alveolar-Velar																
voiceless	/t/-/k/	4	4	5	5	4	5	0	3	2	0	1	2	0	4	
voiced	/d/-/g/	2	2	2	1	2	1	0	2	2	0	0	0	2	3	
nasal	/n/-/ŋ/	0	2	0	0	0	1	0	1	0	0	0	0	0	2	
Velar-Bilabial																
voiceless	/k/-/p/	1	4	1	2	1	2	0	0	1	0	1	2	1	2	
voiced	/g/-/b/	0	1	1	0	0	1	1	3	0	0	2	0	1	4	
nasal	/ŋ/-/m/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total		46		40		41		29		18		23		42		239
Fast-Cosens - Wepman																11

* Initial ** Final

included in Appendix B. The original form of the test may be found in Appendix A. Word-pair items deleted from the initial test are designated by asterisks.

SUMMARY

This chapter reviewed the theoretical background and construction of the S-N Auditory Discrimination Test. The results of the initial form of the SNADT administered during the Pilot Study were subjected to a Test Item Analysis computer program. Interpretation of the item analysis yielded two criteria: a difficulty index and a biserial correlation which were used to retain or eliminate test items for the final form of the research instrument. The revised form of the SNADT was used to appraise the auditory discrimination ability of the subjects in the test sample.

CHAPTER 4

THE DESIGN OF THE RESEARCH

This chapter contains a description of the experimental design of the study. A brief overview of the research design is followed by a review of the testing instruments utilized in the study. An account of the statistical treatment of the data precedes a description of the characteristics of the sample in the study.

I. DESIGN OF THE STUDY

The present study was designed as a longitudinal study to investigate developmental aspects of auditory discrimination in relation to achievement in beginning reading. To appraise specific segments of auditory discrimination, the S-N Auditory Discrimination Test, the research instrument, was constructed. The details of the test with respect to construction of word-pair test items, initial findings and revision were discussed in the preceding chapter. As research studies indicate the impossibility of investigating auditory discrimination ability of young children in isolation from the total process of auditory perception, it was considered important to assess auditory acuity and auditory memory span over the same period of time. All auditory tests were administered individually to children in the study during their final month in Kindergarten and their third month in Grade One. During the children's sixth month in Grade One, reading achievement

was assessed by means of a group silent reading test and individual oral reading tests. Intelligence tests were administered to children during their third month in Grade One. Table 4.1 summarizes tests administered and time of administration.

TABLE 4.1

SUMMARY OF TESTS ADMINISTERED AND TIME OF ADMINISTRATION

Test Administered	Time of Administration K.	Grade One (third month)	Grade One (sixth month)
Audiometric Test Maico F1	*	*	
S-N Auditory Discrimination Test	*	*	
Auditory Memory Span for Letters	*	*	
Auditory Memory Span for Syllables	*	*	
California Short-Form Test of Mental Maturity		* *	
Slosson Oral Reading Test			*
Neale Analysis of Reading Ability			*
Gates-MacGinitie Reading Test			*

The following variables were also considered to be important factors to investigate, as research studies have reported inconsistent correlations between these variables and auditory discrimination:

(a) Sex

(b) Chronological age

(c) Language environment in the home

(d) Number of siblings in the family

(e) Position of child in the family.

II. INSTRUMENTATION

The auditory tests and the standardized intelligence and reading tests used in the study are described in the following section. Reasons for the use of these tests are given and methods of administration and scoring are indicated.

Auditory Tests

Auditory acuity. As auditory acuity appears to be basic to auditory perception of speech sounds and as scientific investigations (Poling, 1968) have indicated that an individual audiometric test is the most valid and reliable test of auditory acuity, individual audiometric tests were administered to determine the hearing efficiency of the 100 subjects in the test sample and to investigate the degree of relationship between auditory acuity and auditory discrimination in relation to beginning reading.

The Maico F1, an instrument of high scientific accuracy, was used by the investigator or a trained assistant to measure hearing acuity. Acuity was tested at all frequencies ranging from 250 cycles to 8000 cycles per second and for each ear, since it is known that young subjects often show loss at low or high frequencies and not at other frequencies, or loss in one ear and not the other ear.

For the administration of this test, the child was seated with his back to the examiner and asked to indicate whether or not he could hear the pure-tone sound by raising or lowering his hand. To insure

that the child knew how to indicate his responses and was attending to the right stimulus, practice was provided at various levels of intensity. Actual recording on the audiogram was started beginning at the 1000 frequency level. Each frequency was tested by first increasing the intensity until the subjects could hear the sounds and then decreasing the sound until the subject could no longer hear it again. The audiogram of each child's performance on the test provided data concerning hearing acuity for left and right ears.

Although Newby (1964) and Oberg (1970) found that it was necessary to spend more than one session when attempting to achieve pure-tone threshold measurements on young children, the present investigator did not have this difficulty. In a few instances, young subjects were retested when the examiner had doubts concerning the validity of the audiometric test results. That is, if the audiogram indicated a serious decibel loss, the child was retested. The ease with which children handled the earphones and responded to the acuity test was perhaps due in part to the fact that the Kindergarten children were administered auditory sweep tests by the school nurse prior to and during the present investigation. Furthermore, in one school 35 Kindergarten children involved in the present study had been tested using the Zenith Za-4T Verbal Auditory Screening for Children. At that time the investigator (Eagan, 1970) reported 15 of the children tested had been referred for further testing by a more qualified person. As a result of Eagan's referrals, one child was found to be partially deaf and the other children's problems were overcome by syringing the ears. While previous to the present study some children's hearing problems had been remedied, during the present investigation the previously

mentioned child with the severe hearing problem was identified using a pure-tone audiometer.

On the basis of the new Audiometric Standard Zero Reference as indicated by the International Standard Organization (Broderick and Kranz, 1965:570-571), subjects in previous studies who had losses of 25 decibels at two or more frequencies or 30 decibel loss at any single frequency were eliminated from the study. While audiograms indicate hearing level by decibel loss, in this study the investigator emphasized the importance of research studies which seem to indicate that lowered acuity in the young child improves with age. Furthermore, it is also possible that hearing loss may not have interfered with the acquisition of language and that audiograms of young children become more accurate as the child learns to "attend" to the proper stimulus. Based on the assumptions that lowered acuity may improve with age as hearing matures or may be compensated for as learning occurs, all Kindergarten subjects were retained in the present study and retested in Grade One.

Auditory Discrimination

Auditory discrimination ability was appraised by means of the research instrument, the S-N Auditory Discrimination Test. The construction and revision of the SNADT were discussed in the preceding chapter, Chapter 3.

S-N Auditory Discrimination Test. Prior to the testing period, the SNADT was recorded in a sound proof room by a native Albertan man from the audio-visual department at the University of Alberta as the speaker. In making the recording, the speed was set at 7½ i.p.s. A

one second interval was left between words, and an interval of three seconds was left between word-pairs to enable children to respond within a sufficient time limit.

Auditory discrimination subtests were administered individually by the investigator and trained assistants to subjects in the study during their final month in Kindergarten and again six months later in Grade One. In administering the tests a Sony tape-recorder -- TC 105 -- was used to provide consistency of presentation to all subjects. Tone control was kept constant but volume was regulated according to size and acoustics of the room in which the test was administered.

Administration of the SNADT was similar to that of the Wepman Auditory Discrimination Test. Unlike the Wepman, the examinee was seated facing the examiner. The examinee listened to the word-pair items presented on the tape-recorder and responded verbally as to whether the words were alike or different. A verbal response was decided upon in an attempt to eliminate a factor of inattentiveness which might occur in a passive response such as raising or lowering the hand. To ensure the child's understanding of the testing procedure and to ascertain the child's knowledge of alike or different sounds, the subjects were given some general practice before the playing of the tape recording. Three practice word-pair items were presented to the child at the beginning of the tape recording to allow the child to become accustomed to the volume and tone of the recording, to facilitate administration of the test by having the child become familiar with the time intervals between word-pair items and to make certain the child understood what was required of him. All responses which indicated the child's expression of alike or different were

accepted. To eliminate the factor of practise or learning on results of tests, the five subtests, containing 50 items each, were administered individually in random order. Generally, to avoid factors of fatigue and inattentiveness, the child was not required to complete two subtests in succession. A copy of the revised test with directions for administering and scoring may be found in Appendix B.

Auditory Memory Span

In an attempt to isolate the auditory discrimination variable from other auditory variables, auditory memory span was tested. As there were no adequately standardized auditory memory span tests for word elements available, auditory memory span was measured by two non-standardized auditory memory span tests:

(a) an auditory memory span test for letters

(b) an auditory memory span test for syllables

Both auditory memory span tests were administered individually to all subjects during their last month in Kindergarten and six months later in Grade One.

Auditory Memory Span Test for Letters. The auditory memory span test for letters was constructed by the investigator and validated by comparing it with the digit-span test used in the *Wechsler Intelligence Scale for Children*. The test was an adaptation of the digit-span subtest of the *Wechsler Intelligence Scale for Children*. It was based on stops and nasals and was divided into levels similar to the digit-span test used in the *Wechsler Intelligence Scale for Children*. The stop and nasal sounds were numbered accordingly, /p,t,k/;/b,d,g/; m,n,ŋ/ one to nine, and the corresponding number was replaced with the

designated letter. For example, the digit span item 2-8-6 was substituted by the letter span item T-N-G. Two letters of the alphabet were needed to represent the nasal /ŋ/. Therefore, the letter "c" was substituted because it was the first consonant representing a sound of the alphabet not already used in the test. All letters presented were administered by name. Hence, for each letter, there was a C-V type sound (e.g. /ti/, /nɔ/, /ǰi/). The sounds were said at one second intervals and the child was required to repeat the sounds in sequence. Two attempts were allowed at each level. If the first item in a series was correctly repeated, the second item was not administered. The test was discontinued when the subject failed two of the items in the same series. As for the Wechsler Intelligence Scale for Children, two scores were obtained, one for letters forward, and one for letters backward. The score was dependent upon the number of letters in the series. The highest number of letters correctly produced on each series was added to give a total memory span for letters score. A copy of the Auditory Memory Span Test for Letters with directions for administering and scoring may be found in Appendix C.

Auditory Memory Span Test for Syllables. To isolate further auditory discrimination as a factor, a second test of auditory memory span constructed by Poling (1968), with minor revisions by the investigator, was administered to the subjects in the test sample.

Poling (1968) in her Auditory Memory Span Test attempted to involve sounds which were as dissimilar as possible. The test was validated by comparing it with the Stanford-Binet memory-for-digits subtest. Poling's test differed in two respects from the Stanford-Binet digit subtest, in that the syllable was the basic element rather than

the digit and the levels increased from one to seven syllables rather than from two to eight digits. As in the Binet, each new level involved an increase of one element and three trials were presented at each interval. The score was the largest number of elements for which one of the three trial items was repeated correctly.

The test is composed of commonly used syllables from the Thorndike first thousand word list. In constructing the test, Poling considered the normal juxtaposition of sounds and syllables in the English language. Therefore, although the nonsense word was new, it was composed of known syllables and other sound elements which encouraged blending (Poling, 1968; Reynolds, 1953; Ewers, 1950). It was thus assumed that the hearing of actual syllables arranged into nonsense words is equivalent to the hearing of familiar sound elements arranged in unfamiliar words. This assumption was based on findings of Rossignol (1948) which indicated that audition is more important to the repeating of unfamiliar words than of familiar words.

As this present study was concerned with the environment of consonants, specifically stop and nasal sounds, in relation to simple vowel sounds, three items on Poling's auditory memory span test were revised. That is, when a single vowel was contained in the nonsense word as a single syllable, a consonant was placed either before or after the vowel. Therefore, using the consonant letters of the alphabet sequentially, three new syllables were formed 'ba', 'id', and 'fe'. As the syllable 'cial' could be two syllables, it was revised and retained as 'cal'.

The pattern for the format, administration and scoring of the Poling Auditory Memory Span Test and the criterion for its evaluation

were derived from the memory-for-digits subtests from the 1937 revision of the Stanford-Binet Tests of Intelligence. In scoring test items Poling overlooked a failure to discriminate between the sound represented and a sound within the same frequency level. That is, if a child responded to the item "sut" as "sud", it was not recorded as an error because /t/ and /d/ were considered as middle frequency sounds. In the present study, an error was counted as such. Two scores were obtained from this test. One score was based on the largest number of elements for which one of three trial elements was repeated correctly, and the other score on the total number of nonsense words repeated correctly by the subject. A copy of the test with directions for administering and scoring may be found in Appendix C.

Results of both auditory memory span tests were recorded on test forms designed for this purpose. Scores from both tests were added for a total auditory memory span score. Data collected were used to determine development of auditory memory span over a six month period. Correlations were computed to examine the relationship between auditory memory span and auditory discrimination as well as between auditory-memory span and other variables in the study.

Reading Tests

To determine the relationship between auditory discrimination ability of children entering Grade One and beginning reading achievement, it was necessary and important to administer appropriate reading tests. Two commonly recognized aspects of reading were measured, oral reading and silent reading. All reading tests were administered to Grade One subjects during the month of March, 1971. Copies of all

reading tests may be found in Appendix C.

Oral Reading

Slosson Oral Reading Test. Fundamental to the reading process and basic to beginning reading particularly is the ability to associate sounds with symbols and the ability to recognize the word. Assessment of ability to recognize words presented out of context was obtained through the administration of the Slosson Oral Reading Test. While the test is mentioned in Buros (1965) there are no comments concerning reliability and validity. A reliability coefficient of .99 (test-retest interval of one week) was reported by Slosson (1963), thereby indicating that this test could be used at frequent intervals to measure a child's progress in reading "provided no specific coaching with these particular words had been given."

The Slosson Oral Reading Test, which was administered individually to subjects, consists of word lists arranged in ten levels of increasing difficulty. Each level represents a grade level from primary grade through grade eight and high school. Performance was evaluated in terms of a Grade Level. At the first two levels most of the words were sight words to Grade One children. At the third level, it became increasingly necessary to use some form of phonics or structural analysis. Because results of this test seemed dependent upon sight vocabulary and because the words have been taken from standardized school readers, data collected were used to investigate the relationship between word recognition on this test and reading programs used in the school. Correlations were also calculated to determine relationships between word recognition and auditory discrimination in this study.

Neale Analysis of Reading Ability. The Neale Analysis of Reading Ability was administered to provide an objective measure of growth in oral reading at the first grade level. Test results provided part scores for word accuracy and comprehension aspects of oral reading desirable for this investigation.

The Neale Analysis of Reading Ability is a test of individual oral reading rate, accuracy and comprehension standardized for British children. Buros (1965:844) quotes that the tests have been carefully standardized and shown to have good reliability. Validity for the test was high but no explanation is given as to why scores for rates, accuracy and comprehension were separately validated.

As it is doubtful whether measures of reading rate are of any particular significance for children beginning to read, this individual oral reading test was especially useful for children in this study, because it was possible to obtain an accuracy score and a comprehension score without penalizing subjects for rate of reading. Besides, it was also not only possible to equate a raw score of one point to a reading age, but a score of even less than this could be extrapolated.

The test material consists of six passages of prose graded in length and in difficulty of vocabulary and sentence structure. Each passage is illustrated to provide motivation and interest before reading. As this test was specifically administered for the purpose of obtaining information regarding accuracy of word recognition when context was involved and comprehension of material read orally, subjects in this study were required to read each passage aloud and were scored for accuracy. While the subject was allowed and encouraged to attack words, only a limited time was permitted before the examiner was

required to supply the word and record a refusal. Paragraphs up to a "ceiling" of 16 or more errors were read orally by each subject. After each passage the subject responded to comprehension questions which were entirely recall. In some instances comprehension questions appeared to be answered correctly because of the assistance the child received with recognition of words when reading the paragraph orally.

Publishers' directions were followed in computing individual word accuracy scores and comprehension scores for each reader level and total scores were compared with test norms to determine individual reading ages of the subjects for word accuracy and comprehension. Statistical procedures were used to examine the relationship between oral reading performance and auditory discrimination and to determine the relationship between oral reading and other variables in the study.

Silent Reading

Gates-MacGinitie Reading Test Primary A Form I. A silent reading test which would yield part scores representing at least word recognition and comprehension aspects was also needed to ascertain the relationship that might exist between auditory discrimination and one or both of these aspects of silent reading. The Gates-MacGinitie Reading Test Primary A Form 1 was, therefore, administered to small groups of Grade One subjects.

The Gates-MacGinitie Reading Test consists of a Vocabulary Test which samples the child's ability to recognize or analyze isolated words and a Comprehension Test which measures the child's ability to read and understand whole sentences and paragraphs.

The Vocabulary Test consists of 48 exercises each of which contains four printed words and a picture illustrating the meaning of one of the words. In response to test items the child was required to circle the word that best corresponded to the picture. As the test progressed the exercises gradually became less easy and less common, and words presented in the exercises became more similar in details and general appearance.

The Comprehension Test contains 34 passages of increasing length and difficulty. Each passage is accompanied by a panel of four pictures. The child responds to the question in the passage by marking the picture that best illustrates the meaning of the passage. Criticism, which could be made of both subtests as well as of other silent reading tests at the first grade level, is that it is relatively easy to score at low-first grade level through guessing alone.

Directions in the Teacher's Manual were followed in administering the test. Although the test is not a speed test, norms for the test applied only if time allowances for both subtests were followed exactly.

The Vocabulary Test was given first, as suggested, followed by a suitable rest period before beginning the Comprehension Test. Raw scores were obtained and converted into grade scores for purposes of statistical computations to be used in the interpretation and analysis of data.

Intelligence

In reviewing related literature pertinent to this study, the investigator stated that the factor of intelligence in relation to

auditory discrimination and reading has usually been treated globally. Therefore, it would be more productive to consider individual factors thought to constitute "intelligence" and try to determine the extent to which such factors influence auditory discrimination and beginning reading achievement.

California Short-Form Test of Mental Maturity Level 1. On the basis of the previous statement, the California Short-Form Test of Mental Maturity was selected and administered to the subjects in the test sample during the third month in Grade One. Level 1 of the test was selected as it was recommended for testing mature first-grade pupils who had experienced a Kindergarten program of a more formal nature. Furthermore, the test itself was one of the few group tests of intelligence which provided both a language and a non-language score at the Grade One level. Besides, the availability of part scores which measured mental development in terms of four statistically-derived factors: logical reasoning, numerical reasoning, verbal concepts and memory, was particularly advantageous to this study. By correlating auditory discrimination ability to various aspects of intelligence rather than to just a gross score, it would be possible to investigate specific relationships of intelligence to auditory discrimination and reading.

Instructions for the administration of the test as outlined in the Examiner's Manual were followed. The test was administered by the investigator to small groups of children in a single testing session. The seven timed units of the test were presented in the same order as they appeared in the test booklet. A short break, as recommended, was given between the Non-Language and Language Sections of the test. One

of the limitations of this test, particularly in reference to this study, was the demands placed on the auditory ability of the child with respect to the oral presentation of tests. Another limitation as cited in Buros (1959) is the lack of concrete evidence as to the meaning and practical usefulness of the "factors." However, there is "sufficient research available to warrant the use of separate language and non-language scores from the test (Buros, 1959)."

One advantage of the test, then, was the obtaining of a separate mental age and intelligence quotient for the Language and Non-Language Sections. In addition to this a total mental age and total intelligence quotient were obtained. Results of the tests were analyzed and correlations between intelligence and auditory discrimination were examined. In addition, the relationship between intelligence and reading achievement was investigated. A copy of the California Short-Form Test of Mental Maturity may be found in Appendix C.

Data collected from the administration of auditory tests, intelligence tests and reading tests as well as pertinent data collected from the cumulative record cards were recorded and analyzed by a variety of statistical techniques.

III. TREATMENT OF THE DATA

In order to examine the hypotheses set forth previously, the following statistical procedures were undertaken. Computing programs prepared by the Division of Educational Research Services at the University of Alberta were used for all analyses.

Item Analysis

Three item analyses were carried out in the study, one for the Pilot Study and two for the main investigation. The main objective of the item analysis in the Pilot Study was to obtain difficulty indexes and biserial correlations of test items to refine the research instrument, the S-N Auditory Discrimination Test.

In the main investigation two item analyses were carried out after testing in Kindergarten and later in Grade One. In addition to establishing the reliability and validity of the SNADT, the difficulty indexes of both item analyses provided information to compare performance and possible development of students in Kindergarten and Grade One with respect to discrimination of sound contrasts contained in test items.

Pearson Product-Moment Coefficient of Correlation

A variety of correlation coefficients were calculated to determine if a linear relationship existed between auditory discrimination and related auditory variables of acuity and memory span. Correlation coefficients were also calculated between auditory discrimination and reading achievement as well as between auditory discrimination and the following variables: chronological age, sex, intelligence and language environment.

Two-Way Analysis of Variance

A two-way analysis of variance was used to test whether there was any significant interaction between oral and silent reading and any significant main effect due to auditory discrimination on oral and silent reading.

t-tests for the Significance of Differences Between Means

To investigate the significance of differences between means two types of t-test programs were used. The first involved a correlated t-test for the significance of differences between the performance of the total group on auditory acuity, discrimination and memory span in Kindergarten as compared to the performance of the group in Grade One. The second involved a t-test for the significance of difference between the mean scores of high and low discriminators. Welch approximations were used as heterogeneous variances were observed.

IV. CHARACTERISTICS OF THE SAMPLE

Population and Sample

As the study was designed to investigate the auditory discrimination ability of young children and to determine the effect auditory discrimination ability might have on initial reading achievement, the study required children who would be entering Grade One without having had formal instruction in reading. The Edmonton Separate School Board was approached to aid in determining the Kindergarten children who would be considered eligible for the test sample. Although there were many private Kindergarten classes in Edmonton, they were not affiliated in any way with the Edmonton Separate School Board. This sampling of the total population of Kindergarten children was, therefore, eliminated from the study. At the time of this study, there were only six Kindergarten classes in Edmonton under the jurisdiction of the Edmonton Separate School Board. These six classes were in three schools situated in different areas of Jasper Place. Children were admitted to any of these classes upon the request of parents who paid a nominal fee.

Previous to 1964, Jasper Place was an organized town in an urban area on the outskirts of Edmonton. At the time of amalgamation with the city of Edmonton, Kindergarten classes which were being conducted in the Jasper Place schools under the auspices of the children's parents were permitted to continue within the schools. It may be concluded, then, that the sample for this study included all Kindergarten children in classes partially subsidized by the Edmonton Separate School Board.

The initial investigation beginning at the end of May, 1970 included 114 children, 58 boys and 56 girls enrolled in six Kindergarten classes. During the intervening six months from the end of Kindergarten to the middle of Grade One, the sample of the study decreased from 114 children to 100 children, a decrease of 14 subjects. These 14 children, having moved oustide the city limits to other towns, provinces or countries, were dropped from the study.

From Table 4.2 it may be noted that two Kindergarten classes were bilingual French classes. Instruction in both of these classes was, for the most part, in French. Although 31 children, approximately 27 per cent of the initial test sample, were enrolled in bilingual classes in Kindergarten only 15 children remained in bilingual classes in Grade One.

Subjects attending Kindergarten classes did not necessarily live in the neighborhood in which the three schools were located. Upon entrance to Grade One, subjects in the study were required to register in specified school systems within the neighborhood or school districts in which they were living. As a result, 85 of the total sample of 100 children registered for Grade One in 10 elementary schools

in the Edmonton Separate School System and were placed within 17 different classrooms. The remaining 15 children registered for Grade One in 6 elementary schools in the Edmonton Public School System and were placed within 8 different classrooms. It may be seen from Table 4.3 that the population of the study was spread over 25 classrooms in 16 different schools.

TABLE 4.2

SUMMARY OF SCHOOL SAMPLE

	Kindergarten	Grade One
Total number of students	114	100
Total number of boys	58	52
Total number of girls	56	48
Number of pupils in bilingual classes	31	15
Number of bilingual classes	2	2
Total number of classes	6	25
Total number of schools	3	16

Cultural Environment

As the Jasper Place area of the city of Edmonton was at one time separate from the city of Edmonton with its own school system, the population of this study could be considered as the total population of a small urban town. Since the annexation of the town to Edmonton, many professional people have moved to the outlying areas of

the city in which several of these schools were located. The other schools in the study were located throughout the Jasper Place area. It may be said, then, with respect to the socio-economic status of the sample, that there was a spread along a continuum from upper-middle class to lower socio-economic status.

TABLE 4.3

SUMMARY OF NUMBER OF CHILDREN IN GRADE ONE CLASSROOMS AND READING PROGRAMS TAUGHT IN CLASSROOMS
N=100

Number of Schools	Number of Classrooms	Number of Children in Class and Reading Program Taught		
A	3	a. 13-Y**	b. 11-Y	c. 7-Y
B	3	a. 14-Y	b. 6-0	c. 3-0
C	2	a. 7-L	b. 6-L	
D	2	a. 5-Y	b. 3-Y	
E	2	a. 2-L	b. 2-L	
F	1	a. 4-Y		
G*	12		17 (3-L, 6-Y, 8-0)	

* 10 schools with 1 or 2 children

** Reading Program Y - Young Canada Reader

L - Language Experience Approach

0 - Other Conventional Reading Program

Socio-economic status <u>per se</u> was not investigated in this study. One of the reasons for this decision being made by the investigator was the questionable validity of socio-economic scales

particularly in the Province of Alberta at the present time (Robertson, 1966:133). Another reason for not investigating socio-economic status was the extreme sensitivity on the part of some parents about providing information. Oberg (1970:47) in a study conducted in Edmonton used a revision of the Gough Home Index Scale. Because of the extremely private nature of many of the questions on the Gough Scale, Oberg reported she would have strong reservations about using this type of instrument in a future study. In relation to the present study, it was felt that if a difference in language ability existed among those of varying socio-economic status it would be evenly distributed throughout the test sample because of the seemingly widespread range in socio-economic status among the test sample. Furthermore, research studies (Winitz, 1969:147) have inferred that lack of a stimulating environment for any child regardless of socio-economic status affects the language development of the child. Therefore, the environment of language factors within the home, which might affect the auditory discrimination ability of a child, were considered to be of importance. Information was sought concerning the following:

(a) language spoken in the home,

(b) the first language of the parents,

(c) the number of siblings in the family,

(d) the position of the Grade One child in the family.

Data concerning these variables were obtained from the cumulative record cards and verified as far as possible through interviews with the principals, the teachers and the children in the test sample.

Language spoken in home. From the data collected it was observed that 68 subjects in the test sample were from homes in which

English was the predominant language. Of the remaining 32 subjects, 19 were from homes in which French was spoken, 4 from homes in which German was spoken and 2 from homes in which Dutch was spoken. While 2 subjects were from homes in which Ukrainian was the first language of the parents, English was the language spoken in the home. Of the remaining subjects included in the test sample, 2 were from homes in which the first language of the parents was Italian, Polish or Greek and 2 from homes in which the first language of one parent was Slavic or Norwegian. Table 4.4 reports the language environment in the homes of the subjects in the test sample.

TABLE 4.4

LANGUAGE ENVIRONMENT IN THE HOME

Language Environment in the Home	Number of Subjects
English	68
French	19
German	4
Dutch	2
Ukrainian	2
Italian	1
Polish	1
Greek	1
Slavic (Jugoslav)	1
Norwegian	1

As it was possible that the 68 subjects in the English language environmental group and the 32 subjects in the Non-English group differed significantly on factors pertinent to the question of auditory discrimination ability in English and its relationship to beginning reading achievement in English explored in this study, a t-test, using Welch approximations, was undertaken to investigate differences between mean performance scores of the English and Non-English groups.

From Table 4.5 it may be seen that there is a significant difference $p < .01$ between auditory discrimination means of the English and Non-English groups for English. While the total auditory discrimination test score mean of 207.69 for the English groups is above the Grade One mean 198.38, the mean 179.56 for the Non-English group is below the Grade One mean. However, the standard deviations of 32.43 and 44.83 indicate a wide spread of scores for both the English and Non-English groups in performance on the SNADT.

Significant differences also exist between total mean scores of the English and Non-English groups on auditory memory span ($p < .01$), intelligence ($p < .01$), silent reading ($p < .01$), oral reading accuracy ($p < .01$) and oral comprehension ($p < .05$). Differences indicated between the English and Non-English groups in performance of auditory tasks in relation to reading achievement are considered in discussing the findings of the study.

Siblings in the Family

The number of siblings in the families of the subjects in the test sample is indicated in Table 4.6. For comparative purposes the

TABLE 4.5

MEANS AND STANDARD DEVIATIONS ON AUDITORY ACUITY, AUDITORY DISCRIMINATION, AUDITORY MEMORY SPAN, INTELLIGENCE AND READING ACHIEVEMENT SCORES OF THE ENGLISH AND NON-ENGLISH GROUPS IN GRADE ONE
N=100

Variable	Mean Eng. N=68	Mean Non-Eng. N=32	S.Dev. Eng.	S.Dev. Non-Eng.	Mean Adj.DF	Mean t'	P	Sign.
Chronological Age	76.81	76.50	3.56	3.41	63.27	.417	.678	NS
Auditory Discrimination	207.69	179.56	32.43	44.83	46.84	3.179	.002	**
Auditory Acuity	89.91	73.91	105.39	65.15	90.71	.901	.369	NS
Auditory Memory Span	9.10	8.12	1.75	1.93	55.65	2.435	.012	**
Intelligence Quotient	112.22	100.00	12.33	8.56	84.06	5.745	.001	**
Mental Age	85.43	76.69	9.01	7.62	70.98	5.037	.001	**
Silent Reading (Gates)								
Vocabulary	21.47	15.53	6.91	5.62	73.57	4.573	.001	**
Comprehension	20.03	15.50	6.95	4.86	83.61	3.763	.001	**
Oral Reading (Neale)								
Word Accuracy	86.54	78.22	7.63	16.00	37.80	2.798	.008	**
Comprehension	82.81	76.81	7.17	14.76	38.05	2.181	.035	*
Word Recognition (Slosson)	15.26	10.56	8.02	6.73	71.48	3.061	.003	**

"t'" is a Welch approximation

** $p < .01$

* $p < .05$

subjects, depending upon the number of siblings in the family, were divided into three groups:

(a) Group One - 27 subjects with 1 or 2 children in family,

(b) Group Two - 44 subjects with 3 or 4 children in family,

(c) Group Three - 29 subjects with 5 or more children in family.

TABLE 4.6

NUMBER OF SIBLINGS IN FAMILY

Number of Siblings in Family	Number of Subjects
One	2
Two	25
Three	28
Four	16
Five	15
Six	9
Seven	2
Eight	1
Nine	2

Position in Family

With respect to position in the family, the test sample was also divided into three groups of youngest, middle of the family or oldest. The following groups were established:

(a) 45 subjects were the youngest in the family

(b) 33 subjects were in the middle position in the family

(c) 22 subjects were the oldest siblings.

From data collected concerning language in the home, the number of siblings in the family and the position of the child in the family information was sought to determine the relationship between these three factors and auditory discrimination, intelligence and reading.

Chronological Age

The chronological ages of the subjects in the test sample were taken from the cumulative record cards in the school files. In the third month of Grade One the chronological ages ranged from 70 months or 5 years 10 months to 84 months or 7 years. Although there is a range in difference of 14 months or 1 year 2 months, the extremes in this range as described in Table 4.7 were limited to one subject being 7 years of age while six subjects were not yet six years old.

TABLE 4.7

MEAN CHRONOLOGICAL AGE OF THE GRADE ONE TEST SAMPLE BY SEX

	Number of Subjects	Mean C.A. in months	Standard Deviation	Range in Ages
Boys	52	76.24	3.45	70 - 83
Girls	48	77.26	3.51	70 - 84
Total Sample	100	76.70	3.49	70 - 84

Sex

The number of boys and girls in the total test sample is reported in Table 4.2. Complete data were collected for the 52 boys

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

and 48 girls who composed the final test sample. As differences between means of boys and girls may exist on variables included in this research project, t-test results examined are reported in Table 4.8

It may be seen from Table 4.8 that the slight difference of .06 between the auditory discrimination score of 199.13 for boys and 198.17 for girls is not significant. Although there is little difference between the mean scores of boys and girls on related auditory abilities of acuity and memory span, means for girls are slightly higher. While differences between auditory acuity means of 92.04 for boys and 75.54 for girls are not significant, the difference between total auditory memory span of 8.48 for boys and 9.15 for girls with a probability of .07 approaches significance. As reported in Table 4.8, there are no significant differences between mean scores of boys and girls in relation to the intelligence variable in the study. However, the mean M.A. of 83.46 for girls is slightly higher than that of 81.93 for boys. It may also be seen that the C.A. mean of 77.46 for girls is also higher than the mean of 76.24 for boys. While mean scores on reading tasks indicate that means of girls are greater than those of boys, only differences between means of boys and girls on oral word accuracy and oral comprehension scores are significant ($p < .05$).

While it is plausible that as children progress in school, common language experiences between sexes lessen, it may be seen from Table 4.8 that, with the exception of auditory discrimination, girls mean scores tend to be slightly higher than boys. If auditory perception, as Wepman (1961) contends, is developmental and develops sequentially on three levels and within levels, it is possible that boys in this study had not developed auditory memory span to the same degree

[illegible]

TABLE 4.8

MEANS AND STANDARD DEVIATIONS ON AUDITORY ACUITY, AUDITORY DISCRIMINATION, AUDITORY MEMORY SPAN, INTELLIGENCE AND READING ACHIEVEMENT SCORES OF BOYS AND GIRLS IN GRADE ONE
N=100

Variable	Mean Boys N=52	Mean Girls N=48	S.Dev. Boys	S.Dev. Girls	Mean Adj.DF	Mean t'	Mean P	Mean Sign.
Chronological Age	76.24	77.26	5.45	5.51	94.91	-1.460	.147	NS
Auditory Discrimination	199.13	198.17	35.52	42.97	87.47	.120	.904	NS
Auditory Acuity	92.04	75.54	116.94	57.65	79.90	.914	.353	NS
Auditory Memory Span	8.48	9.15	1.88	1.78	96.94	-1.832	.070	NS
Intelligence Quotient	108.06	108.61	13.82	11.13	97.71	-.222	.852	NS
Mental Age	81.93	83.46	10.19	8.62	98.00	.506	.614	NS
Silent Reading (Gates)								
Vocabulary	18.80	20.48	6.89	7.23	93.86	-1.185	.239	NS
Comprehension	17.46	19.89	5.67	7.56	82.37	-1.792	.076	NS
Oral Reading (Neale)								
Word Accuracy	81.80	86.33	13.59	8.22	88.95	-2.048	.045	*
Comprehension	79.04	83.07	12.14	7.48	91.69	1.998	.048	*
Word Recognition (Slosson)	12.69	15.02	7.39	8.38	90.60	-1.467	.145	NS

"t'" is a Welch approximation

* $p < .05$

as girls. Thus, it may be that girls, not differing significantly from boys in auditory acuity and auditory discrimination ability but having slightly greater auditory memory spans than boys, performed better than boys on oral reading ($p < .05$) and silent reading tasks.

Mental Maturity

Mean scores and standard deviations for the total Grade One sample on the California Short-Form Test of Mental Maturity, Level I are reported in Table 4.9. The results are reported for the Language and Non-Language sections of the test.

TABLE 4.9

MEANS, STANDARD DEVIATIONS AND PERCENTILES ON LANGUAGE AND NON-LANGUAGE SCORES FOR TEST ON MENTAL MATURITY IN GRADE ONE
N=100

Subtest	Mean	Standard Deviation	Percentile
Language	30.25	6.99	62
Non-Language	32.18	6.35	69

To obtain some indication of the performance of the sample on the Language and Non-Language sections of the tests as well as some indication of the performance of the sample in relation to logical reasoning, numerical reasoning, verbal concepts and delayed memory, the mean scores for the total sample were converted to percentiles. The mean percentile on the Language Section was 62. The mean percentile corresponding to the mean score for the total sample on the Non-Language section was the 69th percentile. The difference of two

between the standard scores for the Language and Non-Language Sections has no statistical significance, indicating similar ability in the two areas of the test for this total sample in Grade One. It would appear then that the performance of the sample on the Non-Language and Language sections of the California Short-Form Test of Mental Maturity, as indicated by the percentile ranks corresponding to the mean scores for the total sample, would fall into the second quartile of the population upon which the test was standardized.

The percentiles corresponding to the mean score for the total sample on the four factors of mental development as measured in this test are reported in Table 4.10. The performance of the total sample on the four factors of Logical Reasoning, Numerical Reasoning, Verbal Concepts, and Delayed Memory ranged from the 50th percentile to the 69th percentile. Like the Non-Language and Language sections of the

TABLE 4.10

MEANS, STANDARD DEVIATIONS AND PERCENTILES ON LOGICAL REASONING, NUMERICAL REASONING, VERBAL CONCEPTS AND DELAYED MEMORY SCORES FOR TEST OF MENTAL MATURITY IN GRADE ONE
N=100

Factor	Mean	Standard Deviation	Percentile
Logical Reasoning	24.76	5.37	69
Numerical Reasoning	13.29	3.30	54
Verbal Concepts	16.78	3.71	69
Delayed Memory	7.57	3.04	50

California Short-Form Test of Mental Maturity, the performance of the sample on the four factors of mental development measured in this test would fall into the second quartile of the population upon which the test was standardized. The largest discrepancy of five between any two standard scores for the mental factors has no statistical significance, indicating similar ability in all subtests for the total Grade One sample.

In order to obtain some indication of the performance of the sample, relative to the population upon which the test of mental maturity was standardized, intelligence quotients were derived from the mean total scores. It may be seen from Table 4.11 that the intelligence quotient corresponding to the mean total score was 108. The I.Q. corresponding to the Non-Language scores was 109 and to the Language scores 106. Thus the mean scores for the total group would appear to fall close to the mean for the population upon which the test of mental maturity was standardized. In addition, the mean mental ages 81.17, 83.45 and 82.62 corresponding to Language, Non-Language

TABLE 4.11

MEANS, STANDARD DEVIATIONS, RANGE OF MENTAL AGES AND INTELLIGENT QUOTIENTS ON TEST OF MENTAL MATURITY
N=100

	Language		Non-Language		Total		Range of Total
	Mean	S.Dev.	Mean	S.Dev.	Mean	S.Dev.	
M.A.	81.17	10.01	83.45	9.41	82.62	9.48	51.0 - 104.0
I.Q.	106.41	13.31	109.36	12.12	108.30	12.59	68.0 - 135.0

and total I.Q.'s respectively, also indicate that the performance of the total test sample of this study on the intelligence scale was above the typical given chronological age group six years four months (76.70). At the same time the wide range of four years four months to eight years eight months in mental age (51.0 - 104.0) and of 68.0 - 135.0 in I.Q. reveals there was a wide spread in individual performance scores on the test of mental maturity.

Reading Achievement

To investigate the relationship of auditory discrimination to beginning reading three reading tests were administered and assessed, a silent reading test indicating performance of the test sample on vocabulary and comprehension, an oral reading test indicating performance of the test sample on recognition of words in context and comprehension, and an oral reading test indicating performance of recognition of words in isolation. The mean grade scores, standard deviations, and ranges of scores are reported in Table 4.12. From Table 4.12 it may be seen that oral and silent reading scores ranged from 0 - 4.1, indicating that there are non-readers and very good readers among the test sample.

Silent Reading

The mean grade scores, standard deviations and ranges of scores for the total sample on the silent reading test, the Gates-MacGinitie Reading Test Primary A Form 1, are presented in Table 4.12. Results are given for vocabulary and comprehension subtest scores. As indicated, the mean grade score for the total sample on the vocabulary section was 1.9 and the mean grade score in comprehension was

1.8. Since the subjects were approaching the end of their seventh month in Grade One at the time of the administration of the test, it may be considered that their performance on the Gates-MacGinitie Reading Test was slightly above the mean grade equivalent for the population upon which the test was standardized.

TABLE 4.12

MEANS, STANDARD DEVIATIONS AND RANGE OF SCORES ON READING ACHIEVEMENT TESTS N=100

Test	Mean	Grade Score*	Standard Deviation	Range of Scores
Gates-MacGinitie Reading Test (Primary A Form 1)				
Vocabulary	19.56	1.9	.706	0 - 3.5
Comprehension	18.57	1.8	.668	0 - 3.7
Neale Analysis of Oral Reading (Form A)				
Word Accuracy	83.87	1.9	11.61	0 - 3.8
Comprehension	80.88	1.7	10.52	0 - 4.1
Slosson Oral Reading Test				
Word Recognition	13.75	1.3	.790	.2 - 3.7

* Converted Grade Score

Oral Reading

As mean scores for silent reading were grade level scores, the equivalents corresponding to the mean scores for the total sample in the word accuracy section, 83.87 or 6 years 11 months, and in the comprehension section, 80.88 or 6 years 8 months, of the Neale Analysis of Oral Reading Test were converted into grade level scores using the Schonell formula (Schonell, 1963:41). The converted grade scores,

1.9 for word accuracy and 1.7 for comprehension, are used in discussion. (See Table 4.12.) Like the mean vocabulary score in silent reading the oral word accuracy score is slightly higher than the comprehension score. As each child on the oral reading test was permitted to perform until "ceiling" level for both word accuracy and comprehension was reached, higher scores attained by better readers may account for the wider range in oral reading scores.

Subjects also read words in isolation on the Slosson Oral Read-Test until a "ceiling" level was reached. Although there is only a slight difference in the range of scores on silent and oral reading subtests, Table 4.12 shows that the mean grade score of 1.3 on the Slosson Oral Reading Test is six months lower than mean grade scores of 1.9 for other word recognition subtests.

Correlations between Reading Tests

Pearson product-moment correlations were used to determine the relationship between each of the reading tests administered to the test sample. It may be seen from Table 4.13 that positive correlations exist between subtests of the same reading test ($p < .01$) and between all oral and silent reading subtests ($p < .01$). High correlations of .886 ($p < .01$) and .872 ($p < .01$) are between subtests of the Neale Analysis of Oral Reading Test and the Gates-MacGinitie Reading Test, respectively. Correlations of .865 ($p < .01$) between the vocabulary section of the Gates-MacGinitie Reading Test and the Slosson Oral Reading Test and of .758 ($p < .01$) between the Gates MacGinitie Reading Test and the word accuracy subtest of the Neale Analysis of Oral Reading Test show that subjects with high ability in decoding words with

the aid of picture clues are also high in recognizing words in isolation as in the Slosson Oral Reading Test and in decoding words orally in context as in the Neale Analysis of Oral Reading. The low correlation of .678 ($p < .01$) between the comprehension of silent and oral reading tests may reflect difference in performance on the word accuracy section of the Neale Analysis of Oral Reading Test which required the examiner to supply unknown words after a pause of approximately four seconds. Therefore, a child unable to decode words was able to respond correctly to some comprehension questions when given the unknown words.

TABLE 4.13

CORRELATIONS BETWEEN ORAL AND SILENT READING ACHIEVEMENT TESTS IN GRADE ONE

Reading Test	Silent Reading Gates MacGinitie Voc.	Silent Reading Gates MacGinitie Comp.	Oral Reading Neale Analysis W.A.	Oral Reading Neale Analysis Comp.
Silent Reading				
Gates MacGinitie				
Vocabulary	-	-		
Comprehension	.872**	-		
Oral Reading				
Neale Analysis				
Word Accuracy	.758**	.736**	-	
Comprehension	.639**	.678**	.886**	-
Slosson				
Word Recognition	.865**	.851**	.720**	.568**

** $p < .01$

[illegible]

[illegible]

Relationship between Reading Achievement and Reading Programs

While research studies have indicated the importance of the teacher variable in beginning reading, it was impossible to control for this variable in the study. It was felt that the distribution of 100 pupils in 25 classrooms would help to minimize the teacher variable factor and the auditory discrimination training factor which exist in first grade classrooms. The question was raised, however, as to the effect the beginning reading programs might have on auditory discrimination, word recognition and comprehension. Data were collected, therefore, from the teachers concerning the reading programs being used in each classroom. (See Table 4.3.)

From information obtained from the teachers, it was observed that the total sample could be divided into three program groups:

(a) 20 children using the Language Experience Reading Program

(b) 63 children using the Young Canada Reading Series

(c) 17 children using other conventional basal reading programs.

From these data, comparisons were made to determine the relationships that might exist between auditory discrimination and the reading programs in use in the schools (Table 4.14).

Correlations between children's performance on reading tests administered in this study and reading programs being used in the classroom show that the <u>Slosson Oral Reading Test</u> with a low positive correlation of .31 ($p < .01$) is the only reading test with a significant relationship with the reading program. This finding may account for the low mean score of 1.3 on the oral reading test and may indicate

that performance on the Slosson Oral Reading Test is to some extent dependent upon sight vocabulary taught in the Grade One Reading Program.

TABLE 4.14

CORRELATIONS BETWEEN SILENT AND ORAL READING ACHIEVEMENT SUBTESTS AND READING PROGRAMS IN THE SCHOOL

Reading Subtest	Correlation with Reading Programs
Silent Reading	
Gates-MacGinitie	
Vocabulary	.161
Comprehension	.171
Oral Reading	
Neale Analysis	
Word Accuracy	.126
Comprehension	.010
Slosson	
Word Recognition	.315**

** $p < .01$

Auditory Acuity

As ability to hear pure-tone sound at an intensity of minus 20 decibels in a quiet but not sound proofed room is an accepted standard of satisfactory acuity, it may be seen from Table 4.15 that 26 subjects in Kindergarten fall below the accepted standard of satisfactory acuity compared to only 7 subjects in Grade One. Results of

audiometric testing showing fewer Grade One subjects in decibel ranges below 0 - 2/15 decibels, and an increase in number of subjects from the decibel range 1/35 - 1/70 db. to the decibel range 3/15 - 1/20 db. indicate either development of auditory acuity over a six month period of time or the effects of learning in the auditory acuity testing situation. Statistical analyses of Kindergarten and Grade One subjects' performance on auditory acuity tests in relation to development of auditory acuity and to variables investigated in this study are reported and discussed later in the findings of the study.

TABLE 4.15

AUDITORY ACUITY OF TEST SAMPLE IN KINDERGARTEN AND GRADE ONE N=100

Decibel Range	Kindergarten		Grade One		Total Number of Subjects	
	Boys N=52	Girls N=48	Boys N=52	Girls N=48	K.	Gr.1
0 - 2/15 db.	34	28	37	39	62	76
3/15 - 1/20 db.	5	7	12	5	12	17
2/20 - 1/30 db.	8	9	2	3	17	5
1/35 - 1/70 db.	5	4	1	1	9	2

Auditory Discrimination Ability

To investigate differences between auditory discrimination ability of Kindergarten and Grade One subjects in relation to beginning reading the test sample was divided into four groups. Auditory discriminator groups reported in Table 4.16 were formed on the basis of auditory discrimination scores attained in Kindergarten and Grade

One. The Kindergarten group was formed on the basis of the Kindergarten auditory discrimination mean of 165.23. The three Grade One groups were formed on the basis of the Grade One mean 198.69.

TABLE 4.16

DISTRIBUTION OF HIGH AND LOW AUDITORY DISCRIMINATOR GROUPS IN KINDERGARTEN AND GRADE ONE
N=100

Group	High Discriminators	No.	Low Discriminators	No.
Kindergarten		60		40
Constant	Remained High Discriminators	45	Remained Low Discriminators	23
Inconstant	Attained High Discrimination	17	Failed to retain High Discrimination (i.e. became low discriminators)	15
Total Grade One	High Discriminators	62	Low Discriminators	38

As reported in Table 4.16, the 60 subjects in Kindergarten who attained scores above the test mean 165.23 were designated as high discriminators and the 40 subjects scoring below the mean were considered as low discriminators. In Grade One the Constant group was composed of 45 subjects who remained high discriminators, as they attained auditory discrimination scores above the designated means both in Kindergarten and in Grade One; and 23 subjects who remained low discriminators as they failed to attain auditory discrimination scores above the mean in Kindergarten and Grade One. The Inconstant group consisted of the remaining 32 subjects, 17 subjects who became high discriminators

in Grade One and 15 who failed to retain high discrimination and were designated low discriminators. The total Grade One test sample contained 62 high discriminators, 45 who retained high discrimination and 17 who attained high discrimination ability; and 38 low discriminators, 23 who remained poor discriminators and 15 subjects who failed to reach the Grade One auditory discrimination mean of 198.69. Table 4.17 reports significant differences between auditory discrimination means of high and low discriminators in Kindergarten and Grade One groups ($p < .01$).

TABLE 4.17

MEANS AND STANDARD DEVIATIONS ON AUDITORY DISCRIMINATION SCORES OF HIGH AND LOW AUDITORY DISCRIMINATORS IN KINDERGARTEN AND GRADE ONE

Group	Mean		S.Dev.		Mean			
	H.D.	L.D.	H.D.	L.D.	Adj.DF.	t'	P	Sign
Kindergarten	194.54	116.46	15.55	39.81	45.50	11.692	.001	**
Constant	218.31	155.74	35.35	35.16	44.64	6.930	.001	**
Inconstant	221.12	164.67	11.91	35.95	16.71	5.806	.001	**
Grade One	219.08	159.26	30.66	35.27	70.09	8.643	.001	**

"t'" is a Welch approximation

** $p < .01$

It may be seen from Table 4.17 that means of 155.75, 164.67 and 159.26 of low discriminators in the Constant, Inconstant and Grade One groups respectively are not only below the Grade One mean of 198.89 but also below the designated Kindergarten mean of 165.23. Means of

high discriminator groups are all above the designated Kindergarten and Grade One mean. Results of t-tests determining the differences between means of high and low auditory discriminators in terms of variables examined in the study may be found in Appendix D. Differences indicated are reported and considered in discussing the findings of the study.

Summary

The general description of the sample appeared to indicate the following findings. Complete data were collected for 52 boys and 48 girls. The subjects appeared to be within the normal age range expected of children in the third month of Grade One with a mean of six years four months for the total sample. In terms of the variables of mental maturity and reading achievement, as they were measured in this study, the sample scored slightly above the mean for the population upon which the norms for these tests were based. Range of score in mental maturity and reading achievement reveal a wide spread in individual performance at the Grade One level. With the exception of auditory discrimination scores, mean scores of girls on variables in the study tended to be slightly higher than boys. Differences between means of boys and girls on oral word accuracy and oral comprehension reading scores were significant ($p < .05$) favoring girls. An examination of performance scores of the 68 subjects in an English language environment and the 32 subjects in a non-English environment indicated significant differences between these two groups on factors of auditory discrimination and reading achievement which may be pertinent to the results of this study. This finding is considered when the analysis

of the relationship between performance on the SNADT and language environment is reported in a later section. Differences in performance of high and low auditory discriminators on reading achievement tasks and related variables in this study are also discussed in the analysis of findings in the study.

CHAPTER 5

ANALYSIS OF FINDINGS: AUDITORY DISCRIMINATION

Findings of this study are divided into two parts: those which are concerned with the measurement of auditory discrimination and those which are concerned with the relationship of auditory discrimination to beginning reading achievement and other factors. This chapter reports findings of the study relative to the measurement of auditory discrimination. The chapter presents, first, Kindergarten and Grade One findings which pertain to results of the Item Analysis computer program on the S-N Auditory Discrimination Test; second, those which pertain to the level of performance of the total test population and to differences between means of Kindergarten and Grade One performance; and third, those which pertain to the phonological findings of the study.

I. GENERAL FINDINGS

This first section discusses general findings of the study relative to the research instrument, the S-N Auditory Discrimination Test.

Item Analysis

Results of Kindergarten and Grade One findings on the SNADT, like the Pilot Study, were subjected to a Test Item Analysis computer program processed by the Division of Educational Research Services,

at The University of Alberta. The main objective of the item analysis in the Pilot Study was to determine difficulty indexes and biserial correlations to have objective criteria for eliminating test items for the initial test, which was too long and time consuming. In the main investigation the item analysis served to establish the reliability and validity of the SNADT. In addition to establishing the reliability and validity of the SNADT, the two item analyses of the main study provided data to determine the type of sounds and the environment of sounds which subjects in the study found difficult to discriminate, to examine growth and development of auditory discrimination ability by comparing and averaging difficulty indexes and to determine relationships between auditory discrimination and reading and other variables in the study. The difficulty index of each minimal word-pair item, reported according to sound contrast measured, may be found in Appendix B.

Test Reliability

The Kuder-Richardson formula 20 was used to determine the reliability of the SNADT. A KR-20 reliability score of .98 for both Kindergarten and Grade One, indicating that test items on the SNADT do have high intercorrelations with each other, is reported in Table 5.1.

Difficulty Indexes of Word-Pair Items

Comparisons of Kindergarten and Grade One difficulty indexes of word-pair items on the SNADT are shown in Figure 5.1. Figure 5.1 indicates that some word-pair items were definitely more difficult

than others for Kindergarten and Grade One subjects to discriminate. It may also be seen that as Kindergarten children progressed through Grade One the level of difficulty of word-pair items decreased. In Kindergarten no word-pair items were discriminated by more than 90 children and only 42 items were discriminated by 80 children. In Grade One 120 word-pair items were discriminated by more than 80 children and 37 items by more than 90 children. As in total test score results, difficulty indexes for any word-pair item reveal that there is generally an increase in the ability of pupils from Kindergarten through Grade One to discriminate between the specific sound contrasts included in the SNADT. (See Appendix B.)

TABLE 5.1

RANGE OF SCORES, MEANS AND KR-20 RELIABILITY SCORES OF KINDERGARTEN AND GRADE ONE PERFORMANCE ON THE SNADT

Grade	Range of Scores (1 - 250)	Test Mean	KR-20 Reliability Score
Kindergarten	0 - 233	165.23	.98
One	59 - 241	198.69	.98

Summary

Results of the item analysis of the main study established the reliability and the validity of the SNADT. Difficulty indexes for any word-pair item show a general increase in the auditory discrimination ability of pupils in the test sample.

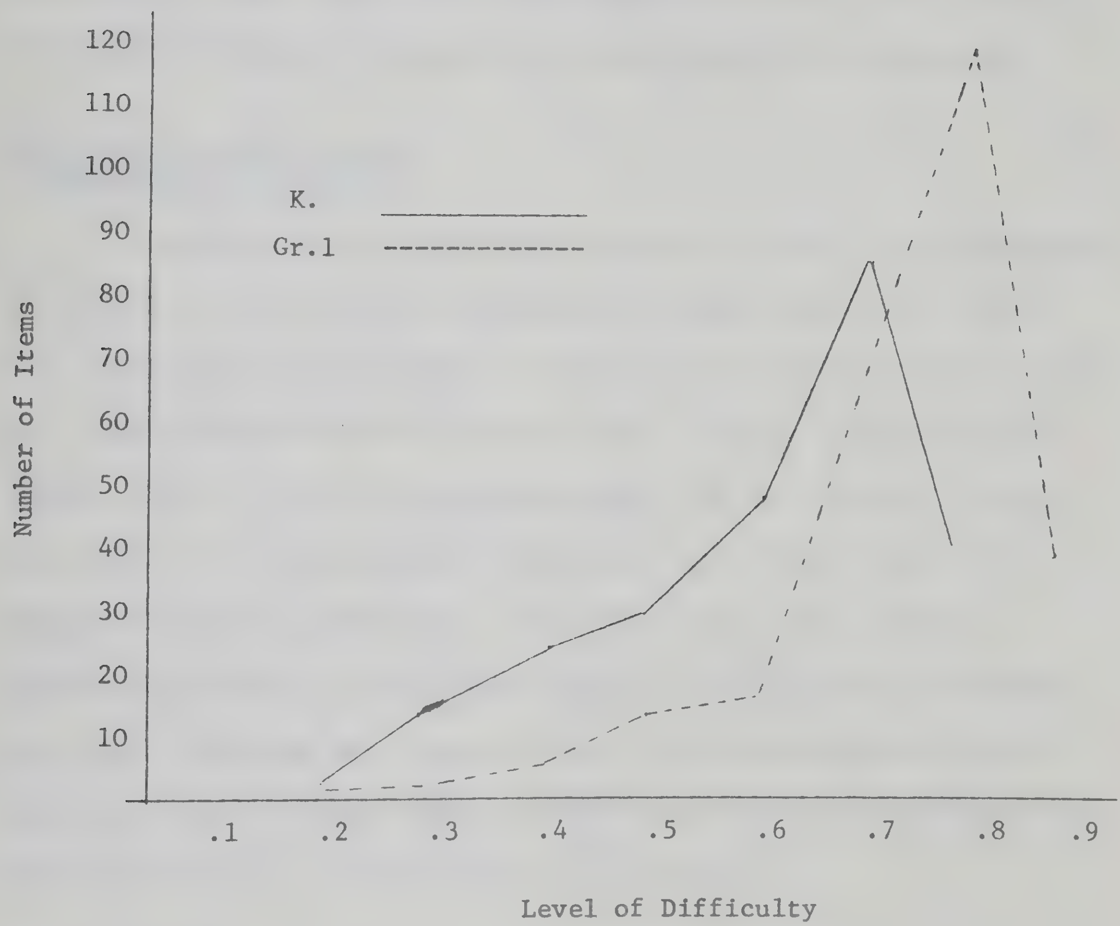


FIGURE 5.1

COMPARISON OF DIFFICULTY INDEXES ON SNADT ITEMS
FOR KINDERGARTEN AND GRADE ONE

II. PERFORMANCE OF TOTAL TEST POPULATION

Results of Pearson product-moment correlations used to determine the relationship among results of the five subtests of the SNADT and the total test are reported in the following section. Findings pertaining to pupil performance on the SNADT and results of t-tests to determine differences between means of performance are discussed.

Correlations among Auditory Discrimination Subtests

Correlation coefficients are reported in Table 5.2 Examination of Table 5.2 shows positive correlations ranging from .661 to .804 ($p < .01$) between subtest scores in Kindergarten and from .791 to .830 ($p < .01$) between Grade One subtest scores. Higher correlations of .829 to .909 ($p < .01$) in Kindergarten and .905 to .928 ($p < .01$) in Grade One exist between subtest scores and total test scores. The higher correlation coefficients among Grade One scores indicate a greater relationship in pupil performance on the auditory discrimination test. Findings also suggest that as children progress through Grade One, they show improvement in their ability to discriminate stop and nasal sounds in varied phonemic environments.

Pupil Performance on the S-N Auditory Discrimination Test

The test mean for each grade, the test variance and the number of pupils within five achievement groups are reported in Table 5.3. Achievement groups were formed by dividing the total number of 250 test items into five sections, each section representing 20 per cent of the total test items. Pupils were placed in achievement groups on

TABLE 5.2

CORRELATIONS AMONG SUBTESTS
OF THE SNADT

Subtest	Test One	Test Two	Test Three	Test Four	Test Five	Total Test
K.	.795**					
Gr. 1	.829**					
Three						
K.	.803**	.782**				
Gr. 1	.826**	.830**				
Four						
K.	.782**	.758**	.804**			
Gr. 1	.793**	.792**	.829**			
Five						
K.	.661**	.721**	.704**	.706**		
Gr. 1	.791**	.824**	.826**	.799**		
Total Test						
K.	.900**	.903**	.909**	.899**	.829**	
Gr. 1	.915**	.923**	.928**	.905**	.912**	

** $p < .01$

the basis of total scores received on the SNADT, those in the Upper 5 representing the number of pupils having over 80 per cent of the word-pair items correct. Total test results of the SNADT reveal the progressive ability of pupils over a period of six months to discriminate auditorily between stop and nasal sounds.

In comparing performance scores of the pupils in Kindergarten and Grade One, test results reported in Table 5.3 show a variance of 2117.86 in Kindergarten and of 1472.14 in Grade One. While the large variances confirm the heterogeneity of the performance of the test sample, when the two variances were tested by the F test, the obtained F of 1.43 was statistically significant at the .05 level of confidence, thereby indicating the growing homogeneity in performance of the test sample.

It may be seen from Table 5.3 that 31 children out of the total Kindergarten sample of 100 subjects were unable to discriminate 40 per cent of the word-pair items. This finding reveals that subjects at the end of Kindergarten were still experiencing difficulty in the auditory discrimination of stop and nasal sounds, sounds which are usually presented early in Grade One reading programs. It may also be observed from Table 5.3 that while only 25 children, one-fourth of the sample, responded correctly to 80 per cent of the items in Kindergarten, 63 children, nearly two-thirds of the sample, responded correctly in Grade One.

The growing homogeneity of the group performance and the higher level of performance of the subjects in Grade One are also indicated in Table 5.4. Table 5.4 shows the frequency distribution of total test scores and reveals a wide range of 250 between Kindergarten scores and

TABLE 5.3

PERFORMANCE OF KINDERGARTEN AND GRADE ONE SUBJECTS ON THE S-N AUDITORY DISCRIMINATION TEST

Grade	Number of Pupils	Test Mean	Test Variance*	Achievement Group	Range of Scores	Per Cent of Test Items	Number of Pupils within Achievement Group
Kindergarten	100	165.23	2117.86	Upper 5	201-250	20	25
				Upper 4	151-200	20	44
				Upper 3	101-150	20	22
				Upper 2	51-100	20	7
				Upper 1	0- 50	20	2
Grade One	100	198.69	1472.14	Upper 5	201-250	20	63
				Upper 4	151-200	20	28
				Upper 3	101-150	20	6
				Upper 2	51-100	20	3
				Upper 1	0- 50	20	0

* $F = 1.43$ which is significant at the .05 level

a smaller but still wide range of 200 between Grade One Scores.

TABLE 5.4

FREQUENCY DISTRIBUTION OF PUPIL SCORES
ON THE SNADT
N=100

Range of Scores	Kindergarten	Grade One
0 - 50	2	0
51 - 75	3	2
76 - 100	4	1
101 - 125	10	2
126 - 150	12	4
151 - 175	16	13
176 - 200	28	15
201 - 225	23	35
226 - 250	2	28

As indicated previously in Table 5.1 scores in Kindergarten actually ranged from 0 - 233 and in Grade One from 59 - 241. The smaller range of 182 at the Grade One level and the finding that only 9 Grade One children were unable to discriminate 60 per cent of the test items compared to the larger range of 233 scores at the Kindergarten level and the finding that 31 children were unable to discriminate correctly 60 per cent of the test items also reveal a higher level of performance in Grade One than in Kindergarten. The narrowing of the range of scores from 233 in Kindergarten to 182 in Grade One and the progressive increase in the distribution of scores supports the theory of

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
		[illegible]

[illegible]

developmental aspects of auditory discrimination of stop and nasal sounds in children during their early school years.

To test for the significance of the differences between means for Kindergarten and Grade One auditory discrimination scores a two-tailed t-test was used. Table 5.5 shows that the test mean of 198.69 for the Grade One sample is significantly greater ($p < .01$) than the test mean of 165.23 for Kindergarten. Table 5.5 also indicates that

TABLE 5.5

MEANS AND STANDARD DEVIATIONS ON S-N AUDITORY DISCRIMINATION TEST SCORES IN KINDERGARTEN AND GRADE ONE

Aud. Dis. Test	Mean		S. Dev.		Variance			Mean		
	K.	Gr. 1	K.	Gr. 1	DF	t	P	DF	t	P
One	34.78	40.14	11.47	8.77	98	-2.906	.005**	99	4.635	.001**
Two	32.35	38.75	11.79	8.71	98	-3.187	.002**	99	5.117	.001**
Three	33.06	39.85	10.25	8.17	98	-2.404	.018*	99	6.272	.001**
Four	33.59	40.50	10.07	8.06	98	-2.243	.027*	99	6.295	.001**
Five	30.90	39.44	8.22	8.08	98	- .175	.861	99	8.929	.001**
Total	165.23	198.69	46.87	38.72	98	-2.077	.040*	99	7.275	.001**

** $p < .01$

* $p < .05$

mean total scores of subtests also increased consistently over the six-month period from Kindergarten to Grade One. These differences between means are statistically significant beyond the .01 level of confidence. The finding that auditory discrimination mean scores increased

significantly from Kindergarten to Grade One lends support to previous research studies (Thompson, 1963; Poling, 1968; and Oberg, 1970) showing that auditory discrimination is developmental. While findings also substantiate recent auditory discrimination studies at the University of Alberta (Fast, 1968; Cosens, 1968; and Eagan, 1970) which suggested that children have difficulty discriminating stop and nasal sounds, results of this study further suggest developmental aspects of auditory discrimination of the finer differentiations of stop and nasal sounds within specific phonemic environments.

Summary

Statistical analysis of data show that there is a steady growth and development in the auditory discrimination ability of young children. While findings substantiate recent developmental studies of auditory discrimination ability, they also reveal that even at the Grade One level some subjects in this study have not mastered the ability to discriminate auditorily between stop sounds and between nasal sounds in varied phonemic environments.

III. PHONOLOGICAL FINDINGS

In the analysis and discussion of the difficulty of stop and nasal sounds in like and unlike word-pair items, consideration is given to the place and manner of articulation of these stop and nasal sounds in relation to tongue height and tongue position of simple vowel sounds. Word-pair items are analyzed both in terms of sound contrasts and in terms of like stop and nasal sounds in initial and final position. Difficulty indexes from the item analyses are used in

determining and comparing difficulty of word-pair items.

Least Difficult Word-Pairs

As there were no word-pair items in Kindergarten correctly discriminated by more than 90 subjects, the 7 least difficult word-pair items discriminated by 85 subjects are reported in Table 5.6. Those items on which more than 95 subjects had correct responses in Grade One are reported in Table 5.7. It may be seen from Table 5.6 that the easiest items to discriminate in Kindergarten are like word-pairs with difficulty indexes ranging from .850 to .890. The fact that only 5 similar word-pair items out of a possible total of 61 were recognized by more than 85 subjects in Kindergarten and 5 by 95 subjects in Grade One (Table 5.7) indicates the Kindergarten and Grade One subjects in the study had difficulty in recognition of similarities in word-pair items. At the same time, the fact that 2 of the 7 easiest items in Kindergarten are unlike word-pairs reveals that Kindergarten children in the test sample are becoming aware of differences in initial sound contrasts (Table 5.6).

Examination of Table 5.8 shows that the least difficult unlike word-pairs for Kindergarten children to discriminate contain sound contrasts in initial position. Least difficult word-pair items are those discriminated correctly by 80 per cent of the Kindergarten sample. Of the 20 items reported, 9 contain voiced stops, 8 voiceless stops and 3 nasals. Eleven items involve bilabial-alveolar contrasts /p/-/t/, /b/-/d/ and /m/-/n/; 7 alveolar-velar contrasts /t/-/k/, /d/-/g/ and 2 the voiced bilabial-velar contrast /b/-/g/. Of the 11 bilabial-alveolar contrasts reported, 4 are voiceless /p/-/t/, 4 voiced /b/-/d/ and 3

TABLE 5.6

EASIEST WORD-PAIR ITEMS AS MEASURED BY THE SNADT IN KINDERGARTEN

Word-Pair Items	Difficulty Index Kindergarten N=85+
nut-nut	.890
gear-beer	.870
met-met	.870
mad-mad	.870
good-good	.860
tote-coat	.850
pot-pot	.850

TABLE 5.7

EASIEST WORD-PAIR ITEMS AS MEASURED BY THE SNADT IN MIDDLE OF GRADE ONE

Word-Pair Items	Difficulty Index Grade One N=95+
good-good	.970
paid-paid	.960
wedge-wedge	.960
puck-puck	.960
nut-nut	.950

[illegible]

[illegible]
[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]
[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

TABLE 5.8

LEAST DIFFICULT UNLIKE WORD-PAIR ITEMS AS MEASURED BY THE SNADT IN KINDERGARTEN

Word-Pair	Vowel* Sound	Consonant Sound	Contrast**	Voicing	Position	Difficulty Index K.
tote-coat	M.B.V.	Stop	Alv.-vel.	Voiceless	Initial	.850
goat-boat	M.B.V.	Stop	Bil.-vel.	Voiced	Initial	.840
pong-tong	L.B.V.	Stop	Bil.-alv.	Voiceless	Initial	.830
boat-dote	M.B.V.	Stop	Bil.-alv.	Voiced	Initial	.830
toot-coot	H.B.V.	Stop	Alv.-vel.	Voiceless	Initial	.830
daub-gob	L.B.V.	Stop	Alv.-vel.	Voiced	Initial	.830
mood-nude	H.B.V.	Nasal	Bil.-alv.	Voiced	Initial	.830
mog-nog	L.B.V.	Nasal	Bil.-alv.	Voiced	Initial	.820
puck-tuck	C.V.	Stop	Bil.-alv.	Voiceless	Initial	.820
poke-toque	M.B.V.	Stop	Bil.-alv.	Voiceless	Initial	.820
tame-came	M.F.V.	Stop	Alv.-vel.	Voiceless	Initial	.820
bong-dong	L.B.V.	Stop	Bil.-alv.	Voiced	Initial	.820
bon-don	L.B.V.	Stop	Bil.-alv.	Voiced	Initial	.810
but-gut	C.V.	Stop	Bil.-vel.	Voiced	Initial	.810
dug-bug	C.V.	Stop	Bil.-alv.	Voiced	Initial	.810
gone-don	L.B.V.	Stop	Alv.-vel.	Voiced	Initial	.810
cook-took	H.B.V.	Stop	Alv.-vel.	Voiceless	Initial	.810
tan-pan	L.F.V.	Stop	Bil.-alv.	Voiceless	Initial	.810
dune-goon	H.B.V.	Stop	Alv.-vel.	Voiced	Initial	.810
mod-nod	L.B.V.	Nasal	Bil.-alv.	Voiced	Initial	.800

*High Front Vowel - H.F.V. High Back Vowel - H.B.V.
Mid Front Vowel - M.F.V. Mid Back Vowel - M.B.V.
Low Front Vowel - L.F.V. Low Back Vowel - L.B.V.
Center Vowel - C.V.

**Bil.-Alv. - Bilabial-Alveolar
Alv.-Vel. - Alveolar-Velar
Bil.-Vel. - Bilabial-Velar

nasals /m/-/n/. When tongue height and tongue position are considered 15 contrasts are in the environment of back vowel sounds, 7 precede the low back vowel /ɔ/, 4 the mid back vowel /o/ and 4 the high back vowels /U/ and /u/. Table 5.9 summarizes the least difficult sound contrasts in word-pair items according to manner and place of articulation, and Figure 5.2 depicts the placement of vowels in these word-pair items. Although no definite conclusions can be drawn concerning the manner and place of articulation of the least difficult sound contrasts in Kindergarten, examination of Figure 5.2 shows that stop sound contrasts preceding back vowel sounds /U/, /u/, /o/, /ɔ/ were easiest for subjects to discriminate. Subjects found word-pair items such as "cook-took', "goat-boat" and "pong-tong" among the least difficult to discriminate. Figure 5.2 also reveals that the voiceless stops /p/-/t/ and /t/-/k/ in the word-pairs "pan-tam" and "tame-came" are the only contrasts preceding the low front vowel /æ/ and the mid front vowel /e/.

Least difficult unlike word-pair items in Grade One (Table 5.10) contain voiced sound contrasts /b/-/d/, /d/-/g/ and /b/-/g/ in initial position. Least difficult word-pair items in Grade One are those discriminated correctly by 90 per cent of the Grade One sample. While 11 of the 20 word-pairs involve initial bilabial-alveolar contrasts, 6 are voiced stop contrasts /b/-/d/, 4 voiceless stops /p/-/t/ and 1 the nasal contrast /m/-/n/. Four of the 5 alveolar-velar contrasts contain the voiced stops /d/-/g/ in initial position and 1 the final nasal contrast /n/-/ŋ/. The 4 bilabial-velar sound contrasts are voiced stops /b/-/g/. When tongue height and tongue position are considered, stop contrasts preceding back vowel sounds /o/ and /ɔ/ and the center vowel

TABLE 5.9

LEAST DIFFICULT WORD-PAIR ITEMS ACCORDING TO PLACE OF ARTICULATION OF STOP AND NASAL SOUNDS ON THE SNADT IN KINDERGARTEN

Type of Sound Contrast	Voiceless Word-pair	Voiceless Difficulty Index K.	Voiced Word-pair	Voiced Difficulty Index K.	Nasal Word-pair	Nasal Difficulty Index K.
Bilabial-Alveolar	pong-tong	.830	boat-dote	.830	mood-nude	.830
	poke-toque	.820	bong-dong	.820	mog -nog	.810
	tuck-puck	.820	bon -don	.810	mod -nod	.800
	tan -pan	.810	dug -bug	.810		
Alveolar-Velar	tote-coat	.850	daub-gob	.830		
	toot-coot	.830	gone-don	.810		
	tame-came	.820	dune-goon	.810		
	cook-took	.810				
Bilabial-Velar			gear-beer	.870		
			boat-goat	.840		
			but -gut	.810		
Like Pairs	pot -pot	.850	good-good	.860	nut -nut	.890
	teak-teak	.840	deign-deign	.830	met -met	.870
	tome-tome	.840			mad -mad	.870
	puck-puck	.830			mode-mode	.830
	coop-coop	.820			noon-noon	.830
	poon-poon	.820			moot-moot	.820
	paid-paid	.820			mod -mod	.800
	could-could	.810			nob -nob	.800
	took-took	.800			mug -mug	.800
	calm-calm	.800				

Tongue Height	Front	Center	Back
	Tongue Position		
High	i teak-teak .840 ɪ		u toot-coot .830 mood-nude .830 noon-noon .830 coop-coop .820 poon-poon .820 moot-moot .820 dune-goon .810 ʊ good-good .860 cook-cook .810 could-could .810 took-took .800
Mid	e deign-deign .830 tame-came .820 paid-paid .820 ɛ met-met .870	ə nut-nut .890 puck-puck .830 tuck-puck .820 but-gut .810 dug-bug .810 mug-mug .800	o tote-coat .850 boat-goat .840 tome-tome .840 mode-mode .830 boat-dote .830 poke-toque .820
Low	æ mad-mad .870 tan-pan .810	calm-calm .800	ɔ pot-pot .850 pong-tong .830 daub-gob .830 bong-dong .820 bon-don .810 gone-don .810 mog-nog .810 mod-nod .800 nob-nob .800 mod-mod .800

FIGURE 5.2

LEAST DIFFICULT WORD-PAIR ITEMS ON THE SNADT ACCORDING TO PLACEMENT OF VOWELS IN KINDERGARTEN

TABLE 5.10

LEAST DIFFICULTY UNLIKE WORD-PAIR ITEMS AS MEASURED BY THE SNADT IN GRADE ONE

Word-Pair	Vowel* Sound	Consonant Sound	Contrast**	Voicing	Position	Difficulty Index Gr.1
bon-don	L.B.V.	Stop	Bil.-alv.	Voiced	Initial	.940
dag-gag	L.F.V.	Stop	Alv.-vel.	Voiced	Initial	.920
big-dig	H.F.V.	Stop	Bil.-alv.	Voiced	Initial	.920
nut-mutt	C.V.	Nasal	Bil.-alv.	Voiced	Initial	.920
kin-king	H.F.V.	Nasal	Alv.-vel.	Voiced	Final	.910
boat-dote	M.B.V.	Stop	Bil.-alv.	Voiced	Initial	.910
but-gut	C.V.	Stop	Bil.-vel.	Voiced	Initial	.910
gone-don	L.B.V.	Stop	Alv.-vel.	Voiced	Initial	.910
tuck-puck	C.V.	Stop	Bil.-alv.	Voiceless	Initial	.910
tong-pong	L.B.V.	Stop	Bil.-alv.	Voiceless	Initial	.900
poke-toque	M.B.V.	Stop	Bil.-alv.	Voiceless	Initial	.900
bag-dag	L.F.V.	Stop	Bil.-alv.	Voiced	Initial	.900
tab-tag	L.F.V.	Stop	Bil.-vel.	Voiced	Final	.900
bode-goad	M.B.V.	Stop	Bil.-vel.	Voiced	Initial	.900
boat-goat	M.B.V.	Stop	Bil.-vel.	Voiced	Initial	.900
toot-coot	H.B.V.	Stop	Bil.-alv.	Voiceless	Initial	.900
gain-deign	M.F.V.	Stop	Alv.-vel.	Voiced	Initial	.900
dude-good	H.F.V.	Stop	Alv.-vel.	Voiced	Initial	.900
mum-numb	C.V.	Nasal	Bil.-alv.	Voiced	Initial	.900
mog-nog	L.B.V.	Nasal	Bil.-alv.	Voiced	Initial	.900

*High Front Vowel - H.F.V. High Back Vowel - H.B.V.
Mid Front Vowel - M.F.V. Mid Back Vowel - M.B.V.
Low Front Vowel - L.F.V. Low Back Vowel - L.B.V.
Center Vowel - C.V.

**Bil.-alv. - Bilabial-Alveolar
Alv.-vel. - Alveolar-Velar
Bil.-vel. - Bilabial-Velar

/ə/ are least difficult to discriminate. Unlike Kindergarten, the least difficult contrasts in the environment of front vowels /eɪ/ and /æ/ in the word-pairs "deign-gain", and "bag-dag" are voiced stops. The 2 least difficult contrasts in final position /n/-/ŋ/ in "kin-king" and /b/-/g/ in "tab-tag" follow the high front vowel /I/ and the low front vowel /æ/ respectively. Table 5.11 summarizes the place and manner of articulation of least difficult word-pair items in Grade One and Figure 5.3 shows the tongue height and tongue position of vowels in the least difficult word-pair items.

Summary

As in Kindergarten, in Grade One the least difficult word-pair items are in the environment of center and back vowel sounds. Unlike Kindergarten, Grade One results are more definitive as initial voiced contrasts in word-pairs such as "boat-dote", "bon-don", "but-gut" and "dag-gag" were easiest to discriminate. While least difficult items in Kindergarten contained only contrasts in initial position, in Grade One contrasts in final position were apparently also easy at this point in children's development.

Most Difficult Word-
Pair Items

Word-pair items which Kindergarten children found most difficult to discriminate are reported in Table 5.12. Table 5.12 reports those items on which fewer than 40 pupils of the total sample in Kindergarten gave correct responses. The 19 items reported include 13 nasals, 5 stops and 1 fricative. Sixteen of the items involve sound contrasts in final position and 3 necessitate discriminating between

TABLE 5.11

LEAST DIFFICULT WORD-PAIR ITEMS ACCORDING TO PLACE OF ARTICULATION OF STOP AND NASAL SOUNDS ON THE SNADT IN GRADE ONE

Type of Sound Contrast	Voiceless Word-pair	Voiceless Difficulty Index Gr.1	Voiced Word-pair	Voiced Difficulty Index Gr.1	Nasal Word-pair	Nasal Difficulty Index Gr.1
Bilabial-Alveolar	tuck-puck	.910	bon -don	.940	nut -mutt	.920
	poke-toque	.900	big -dig	.920	mum -numb	.900
	tong-pong	.900	boat-dote	.910	mog -nog	.900
			bag -dag	.900		
Alveolar-Velar	toot-coot	.900	dag -gag	.920		
			gone-done	.910		
			gain-deign	.900		
			dude-good	.900		
Bilabial-Velar			but -gut	.910	kin' -king	.910
			tab -tag	.900		
			bode-goad	.900		
			boat-goat	.900		
Like Pairs	paid-paid	.960	good-good	.970	nut -nut	.940
	puck-puck	.950	gut -gut	.940	mode-mode	.940
	peak-peak	.920	bug -bug	.940		
	tuck-tuck	.910	dug -dug	.920		
	took-took	.910	dean-dean	.920		
	coop-coop	.910				
	poke-poke	.910				

Tongue Height	Front	Center	Back
	Tongue Position		
High	i peak-peak .920 dean-dean .920 big-dig .920 kin-king .920 winning-winning .910 ɪ		u coop-coop .910 toot-toot .900 good-good .970 took-took .910 ʊ
Mid	e paid-paid .960 deign-gain .900 wedge-wedge .960 bale-vale .910 ɛ	ə puck-puck .950 nut-nut .940 gut-gut .940 bug-bug .940 tug-pug .920 nut-mutt .920 tuck-tuck .920 tuck-puck .910 but-gut .910 dug-dug .900 mum-numb .900	o mode-mode .940 poke-toque .910 poke-poke .910 boat-dote .910 bode-goad .900 boat-goat .900
Low	dag-gag .920 tab-tag .900 bag-dag .900 æ		ɔ bon-don .940 tong-pong .900 gone-don .900 mog-nog .900

FIGURE 5.3

LEAST DIFFICULT WORD-PAIR ITEMS ON THE SNADT ACCORDING TO PLACEMENT OF VOWELS IN GRADE ONE

TABLE 5.12

MOST DIFFICULT WORD-PAIR ITEMS AS MEASURED BY THE SNADT IN KINDERGARTEN

Word-Pair	Vowel* Sound	Consonant Sound	Contrast**	Voicing	Position	Difficulty Index K.
mead-need	H.F.V.	Nasal	Bil.-alv.	Voiced	Initial	.270
beam-bean	H.F.V.	Nasal	Bil.-alv.	Voiced	Final	.280
cam-can	L.F.V.	Nasal	Bil.-alv.	Voiced	Final	.290
meat-neat	H.F.V.	Nasal	Bil.-alv.	Voiced	Initial	.300
main-maim	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.310
tome-tone	M.B.V.	Nasal	Bil.-alv.	Voiced	Final	.320
fret-threat	M.F.V.	Fric.	Lab.-int.	Voiceless	Initial	.330
pome-pone	M.B.V.	Nasal	Bil.-alv.	Voiced	Final	.330
deign-dame	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.340
gid-gig	H.F.V.	Stop	Alv.-vel.	Voiced	Final	.340
gib-gid	H.F.V.	Stop	Bil.-alv.	Voiced	Final	.340
bam-ban	L.F.V.	Nasal	Bil.-alv.	Voiced	Final	.350
nog-nod	L.B.V.	Stop	Alv.-vel.	Voiced	Final	.360
doom-dune	H.B.V.	Nasal	Bil.-alv.	Voiced	Final	.360
tug-tub	C.V.	Stop	Bil.-vel.	Voiced	Final	.370
shape-shake	M.F.V.	Stop	Bil.-vel.	Voiceless	Final	.380
tame-tain	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.390
deam-dean	H.F.V.	Nasal	Bil.-alv.	Voiced	Final	.400
game-gain	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.400

*High Front Vowel - H.F.V.   High Back Vowel - H.B.V.
Mid Front Vowel - M.F.V.   Mid Back Vowel - M.B.V.
Low Front Vowel - L.F.V.   Low Back Vowel - L.B.V.
Center Vowel - C.V.

**Bil.-alv. - Bilabial-Alveolar
Alv.-vel. - Alveolar-Velar
Bil.-vel. - Bilabial-Velar
Lab.-int. - Labiodental-Interdental
Fric. - Fricative

sounds in initial position. Only 2 of the word-pair items involve voiceless contrasts. Both of these items "fret-threat" and "shape-shake" are items from the Wepman Auditory Discrimination Test. When tongue position and tongue height of vowels are considered, 14 items contain front vowel sounds, 1 a center vowel sound and 4 back vowels. Of the 14 items containing front vowels, 6 involve high front vowels /i/, /I/; 6 mid front vowels /e/, and 2 the low front vowel /æ/. Figure 5.4 depicts the most difficult word-pair items on the SNADT according to tongue position and tongue height of the vowel. The most difficult unlike word-pair item containing an initial bilabial-alveolar nasal contrast /m/-/n/ preceding a high front vowel /i/ is "mead-need". The only other difficult contrast in initial position is also a bilabial-alveolar contrast preceding a high front vowel in the word-pair "meat-neat". The other word-pair items which posed the greatest difficulty for Kindergarten subjects to discriminate contain the final bilabial-alveolar nasal /m/-/n/ following front vowel sounds /i/, /e/ and /æ/ as in "beam-bean", "main-maim", and "cam-can". Bilabial-aleveolar nasals are also contained in difficult word pairs following high back vowel /U/ as in "doom-dune" and the mid back vowel /o/ as in "tome-tone".

In Grade One there are only 2 items onthe SNADT on which less than 40 subjects failed to give a correct response as compared to the 19 items in Kindergarten (Table 5.13). One of the most difficult items, "fret-threat" contains the only voiceless fricative contrast on the test /f/-/th/. The other difficult word-pair "main-maim" contains a final bilabial-alveolar contrast /m/-/n/ following a mid front vowel /e/. In addition to these 2 difficult items, Table 5.13 presents the

[illegible]

Tongue Position

Tongue Height	Front	Center	Back
High	i mead-need .270 beam-bean .280 meat-neat .300 deem-dean .400 gib-gid .340 gid-gig .340 ɪ		u doom-dune .360 ʊ
Mid	e main-maim .310 deign-dame .340 shape-shake .380* tame-tain .390 game-gain .400 fret-threat .330* ɛ	tug-tub .370 ə	tome-tone .320 pome-pone .330 o
Low	æ cam-can .290 bam-ban .350		nog-nod .360 ɔ

*Wepman Item

FIGURE 5.4

MOST DIFFICULT WORD-PAIR ITEMS ON SNADT
ACCORDING TO PLACEMENT OF VOWELS IN KINDERGARTEN

TABLE 5.13

MOST DIFFICULT WORD-PAIR ITEMS AS MEASURED BY THE S-N AUDITORY DISCRIMINATION TEST AT MIDDLE OF GRADE ONE

Word-Pair	Vowel* Sound	Consonant Sound	Contrast**	Voicing	Position	Difficulty Index Gr.1
fret-threat	M.F.V.	Fric.	Lab.-int.	Voiceless	Initial	.270
main-maim	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.350
pat-pack	L.F.V.	Stop	Alv.-vel	Voiceless	Final	.420
tome-tone	M.B.V.	Nasal	Bil.-alv.	Voiced	Final	.430
deign-dame	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.440
pome-pone	M.B.V.	Nasal	Bil.-alv.	Voiced	Final	.450
tomb-tune	H.B.V.	Nasal	Bil.-alv.	Voiced	Final	.470
beam-bean	H.F.V.	Nasal	Bil.-alv.	Voiced	Final	.530
mead-need	H.F.V.	Nasal	Bil.-alv.	Voiced	Initial	.530
meat-neat	H.F.V.	Nasal	Bil.-alv.	Voiced	Initial	.540
doom-dune	H.B.V.	Nasal	Bil.-alv.	Voiced	Final	.550
cam-can	L.F.V.	Nasal	Bil.-alv.	Voiced	Final	.550
ton-tongue	C.V.	Nasal	Alv.-vel	Voiced	Final	.560
deem-dean	H.F.V.	Nasal	Bil.-alv.	Voiced	Final	.570
tame-tain	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.570
min-mim	H.F.V.	Nasal	Bil.-alv.	Voiced	Final	.570
mem-men	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.570
pam-pan	L.F.V.	Nasal	Bil.-alv.	Voiced	Final	.570
tug-tub	C.V.	Stop	Bil.-vel.	Voiced	Final	.570
tan-tam	L.F.V.	Nasal	Bil.-alv.	Voiced	Final	.580
cone-come	M.B.V.	Nasal	Bil.-alv.	Voiced	Final	.580
came-cane	M.F.V.	Nasal	Bil.-alv.	Voiced	Final	.590
gid-gig	H.F.V.	Stop	Alv.-vel.	Voiced	Final	.590
bog-bob	L.B.V.	Stop	Bil.-vel.	Voiced	Final	.600
cod-cog	L.B.V.	Stop	Alv.-vel.	Voiced	Final	.600

*High Front Vowel - H.F.V.   High Back Vowel - H.B.V.
Mid Front Vowel - M.F.V.   Mid Back Vowel - M.B.V.
Low Front Vowel - L.F.V.   Low Back Vowel - L.B.V.
Center Vowel - C.V.

**Bil.-alv. - Bilabial-Alveolar
Alv.-vel. - Alveolar-Velar
Bil.-vel. - Bilabial-Velar
Lab.-int. - Labiodental-Interdental
Fric. - Fricative

25 word-pairs on which less than 60 subjects of the test sample failed to give a correct response in Grade One. Similar to the pattern in Kindergarten, word-pairs involving final bilabial-alveolar nasal contrasts following front vowel sounds were most difficult for subjects in Grade One to discriminate (Figure 5.5).

Comparison of difficulty indexes in Kindergarten and Grade One (Table 5.14) reveals that fewer children had difficulty in discriminating word-pair items in Grade One. This is shown by difficulty indexes of word-pair items as "mead-need" with difficult indexes of .270 and .530 indicating that 27 subjects in Kindergarten were able to discriminate the word-pair item correctly and 53 subjects in Grade One. At the same time, subjects are still experiencing difficulty with the initial voiceless fricative comparison "fret-threat" (.330 and .270) and the following final bilabial-alveolar nasal contrast /m/-/n/ after the mid front vowel /e/ as in "main-maim" (.310 and .350) and the mid back vowel /o/ as in "tome-tone" (.320 and .430).

Examination of individual word-pair items (Table 5.14) as to difficulty of stop and nasal sound contrasts shows that 21 word-pairs or 24 per cent of the 68 word-pairs containing bilabial-alveolar contrasts are among the most difficult items to discriminate. With the exception of the voiced bilabial-alveolar contrast in "gib-gid", all other contrasts are the bilabial-alveolar nasal contrast /m/-/n/. While 2 of these contrasts precede the high front vowel /i/, 13 other contrasts follow front vowels, 2 the high back vowel /ʊ/ and 3 the mid back vowel /o/. Of the 55 word-pairs on the SNADT containing alveolar-velar contrasts, 5 or 9 per cent of the contrasts are among the most difficult. Three of these contrasts are voiced as in "cod-

Tongue Position

Tongue Height	Front	Center	Back
High	i mead-need .530 beam-bean .530 meat-neat .540 deem-dean .570 mim-min .570 gid-gig .590 ɪ		u tomb-tune .470 doom-dune .550 ʊ
Center	e main-maim .350 deign-dame .440 tame-tain .570 came-cain .590 fret-threat .270* mem-men .570 ɛ	ton-tongue .560 tug-tub .570 ə	tome-tone .430 pome-pone .450 cone-comb .580 o
Low	æ pat-pack .420 cam-can .550 pam-pan .570 tan-tam .580		bog-bob .600 cod-cog .600 ɔ

*Wepman Item

FIGURE 5.5

MOST DIFFICULT WORD-PAIR ITEMS ON SNADT
ACCORDING TO PLACEMENT OF VOWELS IN GRADE ONE

TABLE 5.14

DIFFICULT SOUND CONTRASTS ACCORDING TO PLACE OF ARTICULATION OF STOP AND NASAL SOUNDS IN WORD-PAIR ITEMS ON THE SNADT IN KINDERGARTEN AND GRADE ONE

Type of Sound Contrast	Voiceless			Voiced			Nasal		
	Word-pair	Difficulty Index		Word-pair	Difficulty Index		Word-pair	Difficulty Index	
		K.	Gr.1		K.	Gr.1		K.	Gr.1
Bilabial-Alveolar				gib-gid	.340	.610	mead-need	.270	.530
							beam-bean	.280	.530
							meat-neat	.300	.540
							deem-dean	.400	.570
							min-mim	.440	.570
							main-maim	.310	.350
							deign-dame	.340	.440
							tame-tain	.390	.570
							game-gain	.400	.600
							mem-men	.430	.570
							came-cane	.450	.590
							cam-can	.290	.540
							bam-ban	.350	.650
							tam-tan	.410	.580
							pam-pan	.470	.570
							tome-tone	.320	.430
							pome-pone	.330	.450
							doom-dune	.360	.580
							tomb-tune	.490	.470
							cone-comb	.550	.580
Labiodental-Interdental	fret-threat	.330	.270						
Alveolar-Velar	pat-pack	.430	.420	gid-gig	.340	.590	ton-tongue	.470	.560
				nog-nod	.360	.650			
				cod-cog	.410	.600			
Bilabial-Velar	shake-shape	.380	.610	tug-tub	.370	.570			
				bog-bob	.490	.600			

cog", one voiceless, "pat-pack" and the other a nasal "ton-tongue". These stop and nasal alveolar-velar contrasts tend to be more difficult to discriminate following center and low vowels /ə/, /ɔ/, /æ/. There are only 2 of the 39 bilabial-velar contrasts or 5 per cent of these contrasts among the most difficult to discriminate. Both of these word-pairs are voiced as in "tug-tub", and "bog-bob". Like the alveolar-velar contrasts, these contrasts follow the center vowel /ə/ and the low back vowel /ɔ/.

Summary

Individual word-pair items were more difficult to discriminate in Kindergarten than in Grade One. The most difficult stop and nasal sound contrasts both in Kindergarten and Grade One contain bilabial-alveolar nasals /m/-/n/ preceding and following the high front vowel /i/ and following the front vowels /e/, /æ/ and the mid back vowel /o/.

Average Difficulty Indexes

To examine in greater depth children's ability to discriminate specific types of sounds, the average difficulty index score for each type of consonant sound contrast in relation to the preceding or following vowel sound was obtained by utilizing the difficulty indexes of the item analysis for each word-pair item. It is within the context of average difficulty index that the difficulty of sound contrasts was determined. That is, as the difficulty of a test item is usually expressed as the proportion of a certain sample who responded to it correctly, an average difficulty of .630 would indicate that approximately 63 per cent of the responses on items measuring voiceless bilabial stop

sounds preceding high front vowel sounds on the SNADT were correct (Appendix B). The following sections report average difficulty indexes and discuss difficulty of word-pair items. In instances where the average difficulty could not be obtained because there was only one item, the difficulty index of the individual item is used.

Like Word-Pairs

To determine more completely difficulty of word-pair items, like word-pairs were examined using average difficulty indexes. Although findings (Table 5.6) reveal that like word-pair items are easiest to discriminate, findings also show that subjects in Kindergarten and Grade One had difficulty in discriminating some like word-pairs. For example, while the word-pair item "good-good" has difficulty indexes of .860 and .970 indicating 14 subjects in Kindergarten and only 3 subjects in Grade One had difficulty recognizing these words as similar, responses to the word-pair "boom-boom" with difficulty indexes of .670 and .720 show that 33 children had difficulty with this item in Kindergarten and 28 children in Grade One.

Average difficulty indexes of like word-pairs are reported in Tables 5.15, 5.16 and 5.17. The most difficult like word-pairs for children in Kindergarten to discriminate with an average difficulty index of .675 contain an initial voiced bilabial /b/ preceding a back vowel /ʊ/ as in the word-pairs "boom-boom" and "boob-boob". In final position the word-pair containing the voiceless /p/ preceded by the mid back vowel /o/ as in "cope-cope" with a difficulty index of .660 was most difficult. As there is little difference in the indexes .660, .670 and .690, it may be stated that like word-pairs containing /m/

and /b/ following a high back vowel /ʊ/ are also among the most difficult like word-pair items (Table 5.17). As in Kindergarten, in Grade One the voiced velar /g/ preceding a mid front vowel /ɛ/ as in "geck-geck" (Table 5.15) and the voiced bilabial /b/ following the high back vowel /ʊ/ were the most difficult like word-pairs to recognize as similar (Table 5.17).

While average difficulty indexes for like word-pair items are higher than average difficulty indexes for unlike word-pairs the average difficulty indexes of .730 and .740 (Table 5.17) reveal that one-fourth of the Grade One students are still experiencing difficulty in hearing similarities in like word-pairs containing voiced bilabial sounds preceding and following the high back vowel /u/, voiceless stops preceding and following the mid back vowel /o/ and the voiced velar /g/ in the environment of a mid front vowel /ɛ/.

Unlike Word-Pairs

Unlike word-pairs discussed in this section involve the following stop and nasal contrasts:

(a) bilabial-alveolar contrasts which include the voiceless stops /p/-/t/, the voiced stops /b/-/d/ and the nasals /m/-/n/;

(b) alveolar-velar contrasts which include the voiceless stops /t/-/k/, the voiced stops /d/-/g/ and the nasals /n/-/ŋ/;

(c) bilabial-velar contrasts which include the voiceless stops /p/-/k/, and the voiced stops /b/-/g/.

TABLE 5.15

AVERAGE DIFFICULTY INDEXES OF LIKE WORD-PAIR ITEMS CONTAINING STOP AND NASAL SOUNDS PRECEDING AND FOLLOWING FRONT VOWEL SOUNDS

Type of Sound	Voiceless		Voiced		Nasal	
	K.	Gr.1	K.	Gr.1	K.	Gr.1
Initial						
Bilabial						
High Front Vowel	.743	.843	.725	.865	-	-
Mid Front Vowel	.820	.960	.765	.865	.870	.840
Low Front Vowel	-	-	-	-	.870	.880
Alveolar						
High Front Vowel	.780	.875	.790	.920	-	-
Mid Front Vowel	.745	.860	.810	.870	.765	.840
Low Front Vowel	-	-	.700	.760	.780	.810
Velar						
High Front Vowel	-	-	.740	.840	-	-
Mid Front Vowel	-	-	.750	.730	-	-
Low Front Vowel	-	-	.770	.820	-	-
Final						
Bilabial						
High Front Vowel	.720	.860	.710	.810	-	-
Mid Front Vowel	.760	.840	.790	.850	-	-
Low Front Vowel	-	-	.770	.820	-	-
Alveolar						
High Front Vowel	.710	.750	.725	.800	.780	.895
Mid Front Vowel	.870	.840	.785	.910	.830	.890
Low Front Vowel	-	-	-	-	-	-
Velar						
High Front Vowel	.770	.900	.770	.860	-	-
Mid Front Vowel	.747	.800	.775	.880	-	-
Low Front Vowel	-	-	.740	.785	-	-

TABLE 5.16

AVERAGE DIFFICULTY INDEXES OF LIKE WORD-PAIR ITEMS CONTAINING STOP AND NASAL SOUNDS PRECEDING AND FOLLOWING CENTER VOWEL SOUNDS

Type of Sound	Voiceless		Voiced		Nasal	
	K.	Gr.1	K.	Gr.1	K.	Gr.1
Initial						
Bilabial Center Vowel	.830	.950	.770	.940	.800	.850
Alveolar Center Vowel	.760	.920	.790	.920	.890	.940
Velar Center Vowel	.730	.870	.730	.940	-	-
Final						
Bilabial	.730	.870	-	-	-	-
Alveolar	.810	.940	-	-	-	-
Velar	.795	.930	.787	.903	-	-

TABLE 5.17

AVERAGE DIFFICULTY INDEXES OF LIKE WORD-PAIR ITEMS CONTAINING STOP AND NASAL SOUNDS PRECEDING AND FOLLOWING BACK VOWEL SOUNDS

Type of Sound	Voiceless		Voiced		Nasal	
	K.	Gr.1	K.	Gr.1	K.	Gr.1
Initial						
Bilabial						
High Back Vowel	.820	.820	.675	.730	.820	.870
Mid Back Vowel	.780	.910	-	-	.830	.940
Low Back Vowel	.795	.870	.730	.770	.800	.890
Alveolar						
High Back Vowel	.800	.910	-	-	.830	.880
Mid Back Vowel	.840	.880	.750	.810	.760	.830
Low Back Vowel	.740	.810	-	-	.800	.870
Velar						
High Back Vowel	.825	.875	.860	.970	-	-
Mid Back Vowel	.720	.835	-	-	-	-
Low Back Vowel	.715	.815	.710	.770	-	-
Final						
Bilabial						
High Back Vowel	.820	.910	.690	.740	.670	.720
Mid Back Vowel	.660	.850	-	-	.840	.880
Low Back Vowel	-	-	.755	.820	.755	.877
Alveolar						
High Back Vowel	.820	.870	.835	.915	.825	.850
Mid Back Vowel	.750	.810	.795	.885	-	-
Low Back Vowel	.850	.870	.770	.890	-	-
Velar						
High Back Vowel	.850	.910	-	-	-	-
Mid Back Vowel	.780	.865	-	-	-	-
Low Back Vowel	-	-	.700	.780	-	-

Bilabial-Alveolar Sound Contrasts

Comparisons of word-pair items containing contrasts of bilabial-alveolar stop and nasal sounds show that the bilabial-alveolar nasal sounds, /m/-/n/, preceding and following simple vowel sounds are contained in word-pair items that children found most difficult to discriminate in Kindergarten and Grade One. As shown in Table 5.18, there is a noticeable discrepancy in difficulty indexes between bilabial-alveolar nasals /m/-/n/ and bilabial-alveolar stops /b/-/d/ and /p/-/t/. This is seen by the low difficulty indexes of .400 in Kindergarten and .620 in Grade One for the bilabial-alveolar nasals /m/-/n/ preceding high front vowels /i/, /I/ in such words as "meat-neat", "knit-mitt" and by the higher difficulty indexes of .750 and .840 for the most difficult voiceless stops contrast /p/-/t/ preceding low front vowels as in "pam-tam" and the higher difficulty indexes of .680 and .850 for voiced contrasts /b/-/d/ preceding the low front vowel /æ/ as in "ban-dan" in Kindergarten and the center vowel /ə/ as in "bug-dug" in Grade One. Although Table 5.18 shows that in Kindergarten voiced bilabial-alveolar stops /b/-/d/ preceding the low front vowel /æ/ are slightly more difficult than the nasal contrasts /m/-/n/, the discrepancy being only .03 in favor of the voiced stops, in Grade One the bilabial-alveolar nasals /m/-/n/ preceding the low front vowel /æ/ were more difficult to discriminate. That is, in Grade One 89 per cent of the subjects discriminated voiced bilabial-alveolar stops correctly and 80 per cent discriminated nasal contrasts /m/-/n/ correctly. A greater gain of 21 per cent is shown in the performance of the test sample in discriminating voiced bilabial-alveolar stops /b/-

TABLE 5.18

AVERAGE DIFFICULTY INDEX OF UNLIKE WORD-PAIR ITEMS CONTAINING BILABIAL-ALVEOLAR SOUND CONTRASTS

Type of Sound	Voiceless /p/-/t/		Voiced /b/-/d/		Nasal /m/-/n/	
	K.	Gr.1	K.	Gr.1	K.	Gr.1
Initial						
Bilabial-Alveolar						
High Front Vowel	.790	.870	.735	.888	.400	.620
Mid Front Vowel	-	-	.752	.852	.640	.800
Low Front Vowel	.750	.840	.680	.890	.710	.805
Center Vowel	.780	.903	.810	.850	.760	.910
High Back Vowel	-	-	-	-	.795	.865
Mid Back Vowel	.820	.900	.830	.910	.660	.885
Low Back Vowel	.810	.880	.815	.910	.797	.867
Final						
Bilabial-Alveolar						
High Front Vowel	.543	.793	.435	.635	.373	.557
Mid Front Vowel	.480	.700	-	-	.387	.520
Low Front Vowel	.580	.754	.543	.740	.406	.596
Center Vowel	.550	.840	.540	.795	.755	.850
High Back Vowel	-	-	-	-	.425	.510
Mid Back Vowel	.590	.700	-	-	.400	.487
Low Back Vowel	.605	.805	.563	.773	.590	.740

/d/, in comparison to the lesser gain of 9 per cent in the performance of the test sample in discriminating bilabial-alveolar nasals /m/-/n/ preceding low front vowels. At the same time, while the average difficulty index of .620 for word-pairs containing initial bilabial-alveolar nasals preceding high front vowels indicates a gain of 22 per cent, items containing these contrasts are more difficult to discriminate in initial position in Grade One. As in other aspects of development, auditory discrimination ability appears to have spurts and plateaus.

As reported in Table 5.18, bilabial-alveolar sounds in final position are more difficult to discriminate than bilabial-alveolar sound contrasts in initial position. The most difficult sound contrasts in Kindergarten with average difficulty indexes of .373 and .387 are bilabial-alveolar nasals /m/-/n/ following high and mid front vowels /i/, /I/, /e/, respectively. Average difficulty indexes of .435 and .480 also reveal that the voiced contrast /b/-/d/ and the voiceless contrast /p/-/t/ are most difficult to discriminate following the high front vowel as in "bib-bid" and the mid front vowel as in "pep-pet". In Grade One, nasal contrasts following back vowels /ʊ/, /o/ with average difficulty indexes of .510 and .487 are most difficult to discriminate. Although the greater gains are shown in comparison of nasal contrasts following high and mid front vowels, average difficulty indexes of .557 and .520 and .596 reveal that more than 40 per cent of Grade One subjects are still unable to discriminate contrasts such as "deam-deen", "came-cane" and "pam-pan". The least gain between difficulty indexes (.08) is in bilabial-alveolar nasal contrasts /m/-/n/ following the mid back vowel /o/ as in the word-pairs "pome-pone",

and "comb-cone". Therefore, it may be stated that at the middle of Grade One approximately 52 per cent of the subjects were still experiencing difficulty in discriminating bilabial-alveolar nasal sound contrasts following the mid back vowel /o/.

Alveolar-Velar Sound Contrasts

Table 5.19 presents average difficulty indexes for the alveolar-velar sound contrasts; /t/-/k/, /d/-/g/, /n/-/ŋ/. As to be expected in English, there are no alveolar-velar nasal contrasts in initial position. As shown in Table 5.19 the most difficult alveolar-velar contrasts in initial position in Kindergarten and in Grade One are the voiceless stop contrasts /t/-/k/ preceding a mid front vowel sound /e/, /ɛ/ as in "tain-cain" and "keg-teg". There is only a slight difference of .024 between the average difficulty index of .664 for voiceless stop contrasts /t/-/k/ and .680 for voiced contrasts /d/-/g/ preceding mid front vowel sounds in Kindergarten. In Grade One the corresponding indexes for these contrasts are .822 and .855. Thus, results show a gain of 16 per cent in performance of the test sample in discriminating voiceless stop contrasts /t/-/k/ as in "take-cake" and a gain of 17 per cent in discriminating voiced contrasts /d/-/g/ as in "game-dame". It may be seen from Table 5.19 that alveolar-velar stop contrasts are less difficult preceding back vowels /o/, /ɔ/ as in "tote-coat" and "gone-don" with average difficulty indexes ranging from .790 to .850 than contrasts preceding front vowel sounds with indexes ranging from .664 to .750. In Grade One the range of difficulty was .822 to .885 for front vowel sounds and .885 to .890 for back vowel sounds.

In comparing alveolar-velar sound contrasts in final position

TABLE 5.19

AVERAGE DIFFICULTY INDEXES OF UNLIKE WORD-PAIR ITEMS CONTAINING ALVEOLAR-VELAR SOUND CONTRASTS

Type of Sound	Voiceless /t/-/k/		Voiced /d/-/g/		Nasal /n/-/ŋ/	
	K.	Gr.1	K.	Gr.1	K.	Gr.1
Initial						
Alveolar-Velar						
High Front Vowel	.725	.865	.665	.845	-	-
Mid Front Vowel	.664	.822	.680	.855	-	-
Low Front Vowel	.670	.833	.750	.885	-	-
Center Vowel	-	-	-	-	-	-
High Back Vowel	.820	.885	.790	.885	-	-
Mid Back Vowel	.850	.890	-	-	-	-
Low Back Vowel	-	-	.820	.885	-	-
Final						
Alveolar-Velar						
High Front Vowel	.625	.780	.460	.720	.785	.870
Mid Front Vowel	.620	.782	.660	.890	-	-
Low Front Vowel	.536	.708	.600	.780	.700	.881
Center Vowel	.687	.830	.535	.810	.470	.560
High Back Vowel	-	-	-	-	-	-
Mid Back Vowel	.675	.760	-	-	-	-
Low Back Vowel	.645	.823	.393	.643	.570	.695

in Kindergarten the low average difficulty index of .393 for word-pairs such as "cod-cog" reveals that the voiced alveolar-velar stop contrast /d/-/g/ following a low back vowel is most difficult. While the most difficult contrast in Grade One with a difficulty index of .560 is the alveolar-velar nasal contrast /n/-/ŋ/ following a center vowel, /ə/, among the least difficult contrasts in final position both in Kindergarten and in Grade One is the nasal contrast /n/-/ŋ/ following a front vowel /ɪ/ as in "kin-king" and "pin-ping". The low difficulty indexes of .643 reveals, as in Kindergarten, that 36 per cent of Grade One subjects still find voiced alveolar-velar contrasts following low back vowels, as "nog-nod", difficult to discriminate.

Bilabial-Velar Sound Contrasts

Comparisons between bilabial-velar sound contrasts /p/-/k/ and /b/-/g/ are not so numerous as comparisons between bilabial-alveolar and alveolar-velar sound contrasts. Table 5.20 shows fewer bilabial-velar stop contrasts in initial position following front vowel sounds and no bilabial-velar nasal contrasts. With the exception of the voiceless bilabial-velar stop contrast /p/-/k/, the only contrast preceding a high front vowel, with an average difficulty index of .710, all other difficulty indexes of word-pair items containing initial bilabial-velar sound contrasts are above .750 in Kindergarten and above .860 in Grade One. Like bilabial-alveolar and alveolar-velar sound contrasts, bilabial-velar sound contrasts are more difficult to discriminate in final position as shown by the indexes ranging from .480 to .770 in Kindergarten and .680 to .870 in Grade One. While in Kindergarten the most difficult bilabial-velar contrast with a difficulty

TABLE 5.20

AVERAGE DIFFICULTY INDEX OF UNLIKE WORD-PAIR ITEMS CONTAINING BILABIAL-VELAR SOUND CONTRASTS

Type of Sound	Voiceless /p/-/k/		Voiced /b/-/g/		Nasal /m/-/ŋ/	
	K.	Gr.1	K.	Gr.1	K.	Gr.1
Initial						
Bilabial-Velar						
High Front Vowel	.710	.860	-	-	-	-
Mid Front Vowel	-	-	-	-	-	-
Low Front Vowel	-	-	-	-	-	-
Center Vowel	-	-	.810	.910	-	-
High Back Vowel	.760	.870	-	-	-	-
Mid Back Vowel	.760	.890	.795	.900	-	-
Low Back Vowel	.780	.890	.780	.850	-	-
Final						
Bilabial-Velar						
High Front Vowel	.604	.798	.770	.800	-	-
Mid Front Vowel	.560	.725	-	-	-	-
Low Front Vowel	.580	.770	.770	.870	-	-
Center Vowel	-	-	.510	.680	-	-
High Back Vowel	-	-	-	-	-	-
Mid Back Vowel	.480	.725	-	-	-	-
Low Back Vowel	.565	.760	.564	.688	-	-

index of .480 is the voiceless stop contrast /p/-/k/ following the mid back vowel /o/ as in "cope-coke", in Grade One the most difficult contrasts with difficulty indexes of .680 and .688 are voiced following the low back vowel /ɔ/ and the center vowel /ə/ as in "bog-bob" and "tug-tub". As in the case of comparisons of alveolar-velar contrasts which show that Grade One subjects found contrasts following center and low back vowels most difficult to discriminate in Grade One, comparisons of bilabial-velar contrasts also reveal that approximately 42 per cent of the subjects in the test sample had difficulty in Grade One discriminating word-pairs containing bilabial-velar contrasts /b/-/g/ following center and low back vowels /ə/ and /ɔ/.

Summary

Comparisons of average difficulty indexes of bilabial-alveolar contrasts /p/-/t/, /b/-/d/ and /m/-/n/ and alveolar-velar contrasts /p/-/k/, /b/-/g/ and /m/-/ŋ/ show that these sound contrasts are more difficult to discriminate in Kindergarten than in Grade One and in final position than in initial position (Table 5.21). These findings show that the children not only developed general auditory discrimination ability from Kindergarten to Grade One but also an ability to discriminate specific sound contrasts within similar environments. Findings also reveal that contrasting of phonemes may be learned in initial position first as children learn to attend to initial cues in words without attending to the total word.

In considering difficulty of contrasts in relation to place of articulation subjects found bilabial-alveolar nasals more difficult to discriminate than alveolar-velar stops and alveolar-velar stops more

TABLE 5.21

AVERAGE DIFFICULTY INDEXES OF WORD-PAIR ITEMS INVOLVING MOST DIFFICULT BILABIAL-ALVEOLAR, ALVEOLAR-VELAR AND BILABIAL-VELAR SOUND CONTRASTS IN KINDERGARTEN AND GRADE ONE

		Initial			Final		
Sound Contrast	Grade	Vowel	Contrast	Ave. Dif.	Vowel	Contrast	Ave. Dif.
Bilabial-Alveolar	K	H.F.V.	/m/-/n/	.400	H.F.V.	/m/-/n/	.373
	One	H.F.V.	/m/-/n/	.620	M.B.V.	/m/-/n/	.487
Alveolar-Velar	K	M.F.V.	/t/-/k/	.664	L.B.V.	/d/-/g/	.393
	One	M.F.V.	/t/-/k/	.822	C.V.	/m/-/n/	.560
Bilabial-Velar	K	H.F.V.	/p/-/k/	.710	M.B.V.	/p/-/k/	.480
	One	L.B.V.	/b/-/g/	.850	C.V.	/b/-/g/	.680
		H.F.V.	/p/-/k/	.860	L.B.V.	/b/-/g/	.688

difficult than bilabial-velar stops. In initial position nasal contrasts and voiceless contrasts were more difficult preceding front vowel sounds. In final position, with the exception in Kindergarten of the difficult nasal contrast /m/-/n/ preceding a high front vowel, contrasts were more difficult following center, mid and low vowel sounds. At the same time, findings in the study are not definitive suggesting that phonemic decisions processing is still developing and that phonemic system learning is a complex and involved process.

For comparative purposes bilabial-alveolar sound contrasts as reported in Table 5.18 are briefly summarized in Table 5.22. Table 5.22 shows most difficult and least difficult sound contrasts and the average number of children who discriminated correctly word-pair items containing these sound contrasts. The most difficult and least difficult alveolar-velar sound contrasts as reported in Table 5.19 and the average number of children who discriminated correctly word-pair items containing these sound contrasts are presented in Table 5.23. Table 5.24 shows the most difficult and least difficult bilabial-velar sound contrasts as reported in Table 5.20 and the average number of children who discriminated correctly word-pair items containing these sound contrasts.

Voicing

As indicated in Table 5.21, average difficulty indexes of difficult sound contrasts, as well as difficulty indexes of individual word-pair items as measured by the SNADT reported in Table 5.12 and Table 5.13, show that word-pair items containing voiced sounds are more difficult to discriminate than word-pair items involving

TABLE 5.22

SUMMARY OF MOST DIFFICULT AND LEAST DIFFICULT BILABIAL-ALVEOLAR SOUND CONTRASTS ACCORDING TO AVERAGE NUMBER OF SUBJECTS RESPONDING CORRECTLY IN KINDERGARTEN AND GRADE ONE
N=100

		Most Difficult			Least Difficult		
Position	Grade	Sound Contrast	Vowel Environment	Average number of subjects responding correctly	Sound Contrast	Vowel	Average number of subjects responding correctly
Initial	K						
		/m/ - /n/	/i/ /I/	40	/m/ - /n/	/ʊ/ /ɔ/	79
		/b/ - /d/	/æ/	68	/b/ - /d/	/o/	83
		/p/ - /t/	/æ/	75	/p/ - /t/	/o/	82
	One						
		/m/ - /n/	/i/ /I/	62	/m/ - /n/	/ɜ/	91
		/b/ - /d	/e/ /ɛ/ /ə/	85	/b/ - /d/	/o/ /ɔ/	91
		/p/ - /t/	/æ/	84	/p/ - /t/	/ə/	90
Final	K						
		/m/ - /n/	/i/ /I/	37	/m/ - /n/	/ə/	75
		/b/ - /d/	/I/	43	/b/ - /d/	/ɔ/	56
		/p/ - /t/	/ɛ/	48	/p/ - /t/	/ə/	60
	One						
		/m/ - /n/	/o/	48	/m/ - /n/	/ə/	85
		/b/ - /d/	/I/	63	/b/ - /d/	/ə/	79
		/p/ - /t/	/o/ /ɛ/	70	/p/ - /t/	/ə/	84

TABLE 5.23

SUMMARY OF MOST DIFFICULT AND LEAST DIFFICULT ALVEOLAR-VELAR SOUND CONTRASTS ACCORDING TO AVERAGE NUMBER OF SUBJECTS RESPONDING CORRECTLY IN KINDERGARTEN AND GRADE ONE
N=100

		Most Difficult			Least Difficult		
Position	Grade	Sound Contrast	Vowel Vowel	Average number of subjects responding correctly	Sound Contrast	Vowel	Average number of subjects responding correctly
Initial	K	/t/ - /k/	/e/ /ɛ/	66	/t/ - /k/	/o/	85
		/d/ - /g/	/i/ /I/	66	/d/ - /g/	/ɔ/	82
	One	/t/ - /k/	/i/ /I/	82	/t/ - /k/	/o/	89
		/d/ - /g/	/i/ /I/	84	/d/ - /g/	/ʊ/ /ɔ/ /æ/	88
Final	K	/d/ - /g/	/ɔ/	39	/d/ - /g/	/e/ /ɛ/	66
		/n/ - /ŋ/	/ə/	47	/n/ - /ŋ/	/I/	78
		/t/ - /k/	/æ/	53	/t/ - /k/	/ə/	68
	One	/n/ - /ŋ/	/ə/	56	/n/ - /ŋ/	/æ/	88
		/d/ - /g/	/ɔ/	64	/d/ - /g/	/e/ /ɛ/	89
		/t/ - /k/	/æ/	70	/t/ - /k/	/ə/	83

TABLE 5.24

SUMMARY OF MOST DIFFICULT AND LEAST DIFFICULT BILABIAL-VELAR SOUND CONTRASTS
ACCORDING TO AVERAGE NUMBER OF SUBJECTS RESPONDING CORRECTLY
IN KINDERGARTEN AND GRADE ONE
N=100

		Most Difficult			Least Difficult		
Position	Grade	Sound Contrast	Vowel	Average number of children responding correctly	Sound Contrast	Vowel	Average number of children responding correctly
Initial	K						
		/p/ - /k/	/i/	71	/p/ - /k/	/ɔ/	78
		/b/ - /g/	/ɔ/	78	/b/ - /g/	/ɝ/	81
	One						
		/b/ - /g/	/ɔ/	85	/b/ - /g/	/ə/	91
		/p/ - /k/	/i/	86	/p/ - /k/	/ə/ /ɔ/	89
Final	K						
		/p/ - /k/	/o/	48	/p/ - /k/	/i/ /I/	60
		/b/ - /g/	/ɝ/	51	/b/ - /g/	/i/ /I/ /æ/	77
	One						
		/b/ - /g/	/ɝ/ /ɔ/	68	/b/ - /g/	/æ/	87
		/p/ - /k/	/e/ /ɛ/ /ɔ/	72	/p/ - /k/	/i/ /I/	79

voiceless sounds. Thirteen of the 19 items in which less than 40 subjects gave a correct response in Kindergarten (Table 5.12) contain voiced nasal sounds and 4 of the items involve voiced stops. While performance increased when voicing was added, Table 5.13 reveals that subjects in Grade One also experienced more difficulty in discriminating items containing voiced sounds than voiceless ones. Of the 25 items in which less than 60 subjects gave a correct response at the middle of Grade One, 19 of these items involve contrasts between voiced nasal sounds and 4 items between voiced stops. In comparing the 20 least difficult word-pair items in Grade One, Table 5.10 shows that 11 of these items contain contrasts of voiced stop sounds in initial position and one item with voiced stop contrasts in final position. Therefore, it may be stated that voiced word-pair items as measured by the SNADT are among the most difficult sound contrasts to discriminate and among the easiest sound contrasts to discriminate. However, the most difficult voiced sounds in Kindergarten and Grade One were nasals and the least difficult voiced stops. Table 5.13 reports that 23 most difficult voiced sounds are in final position and Table 5.10 shows that 14 of the least difficult voiced sounds are in initial position. It would seem that discrimination of word-pair items is not only influenced by place and manner of articulation of stop and nasal sounds, but also by the position of the sound in the word.

Position of Sounds in Words

As shown in Table 5.12 and Table 5.13 subjects in Kindergarten and Grade One had more difficulty in discriminating unlike sound contrasts in final position than in initial position. Cosens (1968:114),

in a study which investigated the effect of auditory discrimination training with 60 Grade One subjects, also found final sounds the most difficult to discriminate. Other studies investigating the auditory discrimination ability of Grade One children (Fast, 1968:109; Oberg, 1970) also found final stops and final nasals among the sounds in final position that posed the greatest difficulty.

Cosens (1968), in examining the aspect of voicing in relation to her study, found that voiced sounds tended to be more difficult for Grade One children. In examining voicing within sound contrasts, however, results were less definitive. Therefore, the findings of this study relative to position and voicing of stop and nasal sound contrasts support Cosens' (1968) findings. It would seem that discrimination of stop and nasal sound contrasts is dependent not only upon the position and voicing of the sound contrast in the minimal word-pair but is also dependent upon the place of articulation of the stop and nasal sound in relation to the tongue position and tongue height of the vowel.

IV. SUMMARY OF PHONOLOGICAL FINDINGS

Findings of this study suggest an orderliness in phonemic decision processing. In agreement with Berko and Brown (1960:578), the sequence may be assumed to be an orderly one in that the "greatest possible phonemic distinctions are made first, with smaller differentiations following later." It would appear that children recognize similarities in word-pairs before learning to attend to differences. This is in accordance with the sequences of steps in perception as defined by Vernon (1958). This development in auditory discrimination not only

indicates maturation but it may also indicate the effect of learning on the subjects' recognition of the importance of awareness of auditory stimuli. From the findings in this study it is evident that Kindergarten and Grade One children do not master the task of seeing similarities in word-pairs, thus suggesting that while phonemic decision processing becomes more accurate, orderliness does not necessitate mastery in sequencing.

Word-pair items were found to be more difficult to discriminate when the contrasts were in final position. It is known that the position of the sound in a word adds to the perceptual cues of duration of sounds that English speaking children learn in order to discriminate words. While the final sound influences the duration of the preceding vowel, the duration of each sound influences the duration of the entire words measured in the SNADT. Children in their early years when confronted with the task of discriminating word-pairs or when decoding words in reading, may attend to initial sounds and thereby learn the distinguishing cues for discrimination of initial sounds prior to learning cues for final sounds. While children attend to initial sounds in words, findings show that minimal word-pairs beginning with the same consonant in the environment of the same vowel were more difficult to discriminate than words beginning with unlike consonants. This is plausible as the child attending to a contrast in initial position has the differentiating cue of two unlike sounds, thereby verifying the fact that in phoneme sequence learning physical stimuli that are most distinctive are learned first, and finer differentiations later. Perhaps this also accounts for some subjects articulating words to reinforce auditory discrimination of word-pair items. At the same

time in the early language development of the child, it is known that words are composed of no more than two different phonemes. It may be that a child, as in initial stages of language acquisition, when first confronted with an auditory discrimination task uses a CV system in discriminating. That is, a child can perceive phonemes only within the context of a syllable. Thus a child who has acquired ability differentiating syllables must learn to identify differences smaller than a syllable, to isolate a phoneme from its environment. This phoneme decision processing probably comes at the time in the life of the child when he is beginning to learn to read and to write. Not only must the child learn to isolate a phoneme from its environment, but the child must also learn to relate this isolated phoneme to the phonemes within the environment.

As the more alike word-pair items are, the more difficult they are to discriminate, the SNADT may have required greater facility in hearing differences between contrasts. It may be that durational cues for distinguishing sounds require finer discrimination when both sounds, as in this study, have the same manner of articulation. Children may learn to use durational cues in perceiving and distinguishing voiced sounds from voiceless prior to learning cues for voiced sounds with different places of articulation. As subjects in the study had less difficulty in discriminating voiced stop contrasts in initial position in more varied contexts than voiceless stops, it may be that sound contrasts in a voiced environment may be learned prior to those in a voiceless environment. It is known that English vowels preceding voiceless consonants are shorter in duration than those before voiced consonants. The shortening of vowels before voiceless consonants is due to an

articulatory activity arbitrarily imposed by the phonological system of English and constitutes learned behavior in English rather than a phonetic universal (House, 1961). Furthermore, the transition is longer after voiced stops because there is no voiceless pause between the explosion and the vowel cancelling the beginning of the transition. As "longer vocalic segments yield longer transition segments, and the transition . . . is one of the primary parameters that distinguish one stop from another (Rudegeair, 1970:57)," it is possible that children learn to attend to this stronger cue for voiced stops prior to cues for voiceless stops.

Although studies by Cosens (1968), Eagan (1970) and Oberg (1970) have shown that when all sound contrasts were considered, subjects performed significantly better on voiceless than on voiced sounds, comparison of pupils' performance on voiced and voiceless within sound contrasts was less definitive. Results of this study also indicate that performance of pupils on word-pair items in relation to manner of articulation of sound contrasts were not definitive. Factors other than manner of articulation appeared to influence the discrimination of sound contrasts.

In considering difficulty of contrasts in relation to place of articulation, bilabial-alveolar contrasts were more difficult than alveolar-velar contrasts and alveolar-velar contrasts more difficult than bilabial-velar contrasts. This finding is contrary to Eagan's (1970:88) in that she found bilabial-velar contrasts among the most difficult to discriminate and hypothesized that the "farther away the points of articulation are from each other the more difficult it is to discriminate the sounds." Findings of this study are not contradictory

to Eagan's findings but support the hypothesis that vowel context affects consonant discrimination. Results of this present study, while not definitive, may be supportive of a theory of phoneme system learning.

It would seem subjects in the study have learned to distinguish between bilabial and non-bilabial sounds. At the same time there is confusion in discriminating alveolar and velar sounds. As in the acquisition of language "when /k/ appears mistakes in both phonemes /k/, /t/ arise, at first, especially those caused by a hyper-correct repression of the expected /t/ in favor of /k/ (Jakobson, 1968:54)." Results of the study seem to indicate that children are beginning to become consistent in their discrimination and are making the finer and yet gross differentiation between front consonants and back consonants, between the bilabial-velar contrasts /p/-/k/, /b/-/g/, and /m/-/ŋ/. While subjects are progressing one more step in acquiring the adult phonemic pattern of English, or advancing in ability to isolate a phoneme from its contextual environment, they are still experiencing difficulty with alveolar sound contrasts. The fact that nasal contrasts were most difficult suggests that children in Grade One may not have mastered the consonant-sonorant distinction necessary for auditory discrimination of nasals within the context of vowel sounds. It is known that nasal resonance brings consonants closer to vowels and when superimposed upon a vocalic spectrum dampens the other formants and deflects the vowel from its optimal pattern (Jakobson, 1962). While nasals influence vowels in much the same manner as voiced stops, studies by Fisher-Jørgensen (1964) (cited by Lehiste, 1970) and Peterson and Lehiste (1960) have reported reverse order for duration of vowels in relation to nasals.

Short vowels were found to be longest before /t/, shorter before /k/ and shortest before /p/, and for long vowels, the decreasing order before the following consonant was /d/>/g/>/g/. For nasals the order was reversed. After short vowels the decreasing order was /m/>/ŋ/>/n/ and following long vowels /ŋ/>/n/>/m/. In speech if an error is made in the duration of one phoneme it is compensated for in the following phoneme. While children are able to use and recognize words involving nasal sounds in speech, they may be experiencing difficulty in discriminating nasal contrasts. The fact that /n/ has the shortest durational cue following short vowels and less differentiation of duration between /m/ and /n/ following long vowels, may explain the difficulty subjects had in discriminating nasal contrasts on the SNADT. This factor perhaps strengthens the hypothesis that specific environments of stop and nasal sounds will have a more favorable effect on the phonemic decision than other environments, and thereby facilitate auditory discrimination of sound contrasts.

As the most difficult sound contrasts were found in the environment of a mid vowel or a high vowel, it is possible that children who have learned to distinguish high vowels from low vowels are still confused in distinguishing mid vowels. Moreover, studies conducted by Wang and Fillmore (1961) confirmed their hypothesis that consonant recognition is better when consonants are adjacent to low vowels, since high vowels have smaller amplitude than low vowels. It may be then that the difficulty in auditory discrimination of word-pairs is not only dependent upon maturation and developmental learning experience, but also upon inherent difficult linguistic features of the phoneme.

While emphasizing the interrelatedness of features of sounds

in the development of auditory discrimination, results show, as in other aspects of language acquisition, that there appears to be a spiral effect operating in the perception of stop and nasal sound contrasts. This seems to be in agreement with Frazer, Bellugi and Brown (1963:121) who stated that a "child rarely acquires the total performance of one language task before demonstrating acquisition of any part of another language task."

Summary

This chapter reported findings of the study relative to the research instrument, the SNADT. Although difficulty indexes of word-pair items reveal subjects in the study have not mastered the ability to discriminate auditorily between stop and nasal sounds in varied phonemic environments in Grade One, statistical analysis of data showed a growing homogeneity ($p < .05$) and a steady growth and development ($p < .01$) in auditory discrimination ability of subjects from Kindergarten to Grade One. In reporting phonological findings of the study, like and unlike word-pair items were considered in terms of the position, place and manner of articulation of stop and nasal sounds in relation to tongue height and tongue position of the preceding or following simple vowel sound. The following chapter analyzes and discusses pertinent findings concerning the relationship between auditory discrimination and beginning reading achievement and other variables investigated in the study.

CHAPTER 6

RELATIONSHIP BETWEEN PUPIL PERFORMANCE ON THE S-N AUDITORY DISCRIMINATION TEST AND RELATED AUDITORY ABILITIES, READING ACHIEVEMENT AND INVESTIGATED VARIABLES IN THE STUDY

This chapter is designed to present further analysis of findings. The chapter is divided into three sections. The first pertains to auditory discrimination as measured by the SNADT and auditory variables of acuity and memory span. The second discusses the relationship between auditory discrimination and reading. The third considers the relationship between auditory discrimination and each of the following variables: chronological age, sex, language environment and intelligence.

I. AUDITORY VARIABLES

This section reports results of Pearson product-moment correlations used to investigate the relationship between performance on the SNADT and auditory acuity and memory span; results of t-tests used to determine growth in acuity and memory span of subjects from Kindergarten to Grade One; and results of t-tests using Welch approximations to investigate differences between means of acuity and memory span scores of high and low auditory discriminators.

Auditory Acuity

Correlation coefficients between total auditory discrimination

scores on the SNADT and total auditory acuity for low, middle and high frequency tones as measured by the Maico F1 audiometer are reported in Table 6.1. It may be seen from Table 6.1 that low negative correlations exist between auditory discrimination and auditory acuity.

TABLE 6.1

CORRELATIONS BETWEEN SNADT SCORES AND AUDITORY ACUITY SCORES IN KINDERGARTEN AND GRADE ONE
N=100

Acuity for:	Correlation with SNADT K.	Gr. 1
Low Frequencies	-.216	-.002
Middle Frequencies	-.188	-.042
High Frequencies	-.127	-.043
Total Frequencies	-.187	-.027

The negative correlations between the SNADT and auditory acuity may be explained by the method of measuring acuity. As acuity for pure-tones is measured by decibels, a decibel being the level of intensity at which a subject can hear sound, the lower decibel score reported indicates the higher level of acuity. For example, a child with a decibel score of five at any given frequency would have better acuity than a child with a decibel score of twenty. As a result, correlations in this study were computed between auditory acuity scores that were high, if acuity were poor, and low, if acuity were good, with auditory discrimination scores that were high if discrimination were good and

low if discrimination were poor. The relationship between auditory discrimination and acuity is, therefore, expressed as a negative correlation.

Although the correlations of -.127 and -.216 in Kindergarten are low, they reveal a slightly greater relationship between auditory acuity and auditory discrimination in Kindergarten than in Grade One. These low correlations suggest that as children become older and progress through Grade One, there is less correlation between auditory acuity and auditory discrimination. Low correlations of -.002 to -.027 in Grade One show very little relationship between auditory acuity and discrimination. It may be that as subjects in Grade One became accustomed to audiometric testing and learned to attend to the appropriate stimuli required in hearing low, middle and high frequency tones, the audiometric testing did not demand from the subjects the attention and set required for these same subjects in performance on the SNADT. As a result, Grade One subjects in the study acquired a greater proficiency in performance of auditory acuity for pure-tones than in auditory discrimination of minimal word-pairs.

While subjects in Grade One acquired a proficiency in responding to auditory acuity stimuli in a testing situation for pure tones of low, middle and high frequencies, all subjects did not attain the same level of acuity. This may be seen from Table 6.2. Table 6.2 reports significant differences between means and standard deviations of Kindergarten and Grade One scores on low, middle and high frequencies ($p < .01$). The progressive increase in hearing acuity of Grade One subjects over a period of six months is shown by the

decrease in mean score, or decrease in decibel loss. A more homogeneous group in Grade One with variations still in level of acuity is revealed by the decrease in standard deviations ($p < .05$).

TABLE 6.2

MEANS AND STANDARD DEVIATIONS ON AUDITORY ACUITY SCORES OF LOW, MIDDLE AND HIGH FREQUENCY IN KINDERGARTEN AND GRADE ONE
N=100

Frequency	Mean K.	Mean Gr.1	S. Dev. K.	S. Dev. Gr.1	Variance DF	Variance t	Variance P	Mean DF	Mean t	Mean P
Low	38.30	29.19	44.08	25.92	98	-7.350	.001**	99	-2.702	.008**
Middle	56.30	35.75	79.42	43.83	98	-11.720	.001**	99	-4.148	.001**
High	32.00	19.25	37.81	30.25	98	-3.574	.001**	99	-5.630	.001**
Total	127.05	84.44	154.07	94.33	98	-8.773	.040*	99	-4.459	.001**

**$p < .01$

*$p < .05$

The finding that subjects' auditory acuity increased from Kindergarten to Grade One substantiates findings of other research studies reporting development of auditory acuity (Kennedy, 1942; Eagles, 1961). Results may also be indicative of the importance placed in recent years in screening young children for hearing deficits. Although audiometric testing of some subjects in this study showed inadequate acuity as measured by decibel loss, results of

earlier screening had detected children with severe hearing losses and children suspected of hearing problems. Referrals to doctors in many instances had remedied minor hearing problems. While subjects in this study became accustomed to audiometric testing, in some instances subjects becoming more attentive to auditory stimuli may have learned to compensate for their deficiency in auditory acuity. These findings lend support then to the contention of Price (1964) that results of auditory acuity studies indicate the effect of learning on hearing. Furthermore, in agreement with Hardy (1960), results suggest that auditory acuity is dependent upon the two factors of maturation and learning.

As reported in Chapter IV under Characteristics of the Sample, four groups of high and low auditory discriminators were formed to research in greater depth the relationship between auditory discrimination ability and investigated variables in the study (See Table 4.17).

Table 6.3 reports no significant differences between auditory acuity mean scores of Kindergarten and Grade One high and low auditory discriminators. It may be seen from Table 6.3 that Grade One subjects in the Inconstant group with the lower mean score 76.33, revealing a higher level of auditory acuity for this group than other discriminator groups, became low discriminators in Grade One, while subjects in the same group with an auditory acuity mean score of 81.47 who were low discriminators in Kindergarten have become high discriminators. Again this finding may be indicating that as subjects progressed through Grade One, auditory discrimination ability is less dependent on auditory acuity and may be more dependent upon factors of attention,

concentration, interest and motivation. It may be that auditory discrimination for Grade One subjects is becoming a unique task, a separate task which these children are beginning to relate to a literal task, to a printed symbol, to reading. Therefore, scores on the SNADT may not have been affected as much by a child's acuity level, as by the child's ability to sustain attention for a length of time and a child's awareness of the need to hear fine differences in sounds.

TABLE 6.3

MEANS AND STANDARD DEVIATIONS ON AUDITORY ACUITY OF HIGH AND LOW AUDITORY DISCRIMINATOR GROUPS IN KINDERGARTEN AND GRADE ONE
N=100

Group	Mean		S.Dev.		Adj.DF	Mean t	P	Sign.
	H.D.	L.D.	H.D.	L.D.				
Kindergarten	108.85	155.51	65.44	233.12	41.86	-1.220	.229	NS
Constant	82,78	95.22	73.16	156.40	27.03	-0.362	.720	NS
Inconstant	81.47	76.33	41.56	73.57	21.50	-0.239	.406	NS
Grade One	82.78	87.76	65.59	129.15	48.92	-0.257	.813	NS

"t'" is a Welch approximation

<u>Auditory Memory Span</u>

Results of Pearson product-moment correlations show low positive correlations between performance on the SNADT and auditory memory span for letters and syllables. Table 6.4 reports correlations in Kindergarten ranging from .126 for memory for letters forward to

.353 ($p < .01$) for memory for letters backward and in Grade One from .233 ($p < .01$) for memory for syllables to .325 ($p < .01$) for total memory span.

TABLE 6.4

CORRELATIONS BETWEEN SNADT SCORES AND AUDITORY MEMORY SPAN SCORES IN KINDERGARTEN AND GRADE ONE
N=100

Auditory Memory Span	Correlation with SNADT K.	Gr. 1
Letters Forward	.126	.238**
Letters Backward	.353**	.243**
Syllables	.245**	.233**
Total Memory Span	.338**	.325**

**$p < .01$

Like differences between Kindergarten and Grade One means of auditory acuity (Table 6.2) and auditory discrimination scores (Table 5.5), the means of auditory memory span increased over a period of six months. It may be seen from Table 6.5 that auditory span for letters forward increased significantly from 2.83 in Kindergarten to 3.31 ($p < .01$) in Grade One and for letters backward from 1.31 to 1.99 ($p < .01$). As would be expected, the reverse memory span for letters is less than for forward span. While the mean of auditory memory span for syllables increased from 3.45 in Kindergarten to 3.49 in Grade One,

the very small increase is not statistcally significant. The small increase in auditory memory span subtest scores from Kindergarten to Grade One suggests a slower rate of development in auditory memory span in comparison to development of auditory acuity and auditory discrimination during the same period of time. This would be in keeping with Wepman's (1962) theory of perception stating that each auditory ability develops at its own rate.

TABLE 6.5

MEANS AND STANDARD DEVIATIONS ON AUDITORY MEMORY SPAN SCORES IN KINDERGARTEN AND GRADE ONE
N=100

Memory Span Test	Mean		S.Dev.		Variance			Mean		
	K.	Gr.1	K	Gr.1	DF	t	P	DF	t	P
Letters Forward	2.83	3.31	1.32	.84	98	-4.764	.001**	99	3.550	.001**
Letters Backward	1.31	1.99	1.22	1.08	98	-1.357	.178NS	99	5.566	.001**
Syllables	3.45	3.49	.85	.59	98	6.386	.001**	99	39.574	.676NS
Total Memory Span	7.54	8.79	2.36	1.84	98	-2.700	.008**	99	5.368	.009**

**$p < .01$

*$p < .05$

Although there is no statistical evidence, the small increase between Kindergarten and Grade One mean scores for memory span for syllables may be explained through observation of two factors: one

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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within the memory syllable span test, the other within the child. In the scoring of the test, for example, a subject was credited with a span of three if he successfully completed one of three items within the series containing three syllables. Although more subjects in Grade One successfully responded to all three items correctly, showing a definite memory span of three for syllables, this is not evident in the statistical analysis. At the same time, while subjects in Kindergarten responded to syllable span items with an exactness and precision similar to the pattern in which the items were presented, Grade One subjects blended syllables in an attempt to phrase or say a "real word." As a result, errors occurred, for example, in such syllable span items as "for id sult" which became "for insult" and "be haps" which became "perhaps." It may be that Grade One subjects in attending to auditory memory span for syllable items were influenced by language factors of auditory blending, intonation and association of sound with meaning. While it is known that responses to the same auditory tasks may be changed when directions for attending to the task are altered, results of the memory for syllable span subtest in this study suggest that responses to the same auditory task may change as the child becomes more familiar with knowledge of words.

While Table 6.5 shows an increase in auditory memory span mean scores, it also reveals a sequencing in the development of specific auditory memory spans during the same period of time. As the higher mean scores, 3.45 in Kindergarten and 3.49 in Grade One, are reported for auditory memory span for syllables, it may be that memory for syllables begins to develop earlier than for letters, and memory for

letters forward earlier than for letters backward. Mean scores of high and low auditory discriminators on auditory memory span subtests (Table 6.6) also suggest development from the greater to the shorter span in the following order: auditory memory for syllables, letters forward and letters backward.

TABLE 6.6

MEANS AND STANDARD DEVIATIONS ON AUDITORY MEMORY SPAN OF HIGH AND LOW AUDITORY DISCRIMINATOR GROUPS IN KINDERGARTEN AND GRADE ONE
N=100

Group	Auditory Memory Test	Mean H.D.	Mean L.D.	S.Dev. H.D.	S.Dev. L.D.	Mean Adj.DF	Mean t'	P	Sign.
Kindergarten	Forward	3.02	2.54	1.20	1.47	69.63	1.702	.093	NS
	Backward	1.70	.69	1.16	1.08	85.32	4.443	.001	**
	Syllables	3.59	3.23	1.88	1.93	79.77	2.611	.010	**
	Total Span	8.23	6.46	2.11	2.38	73.86	4.783	.001	**
Constant	Forward	3.53	2.91	.79	1.24	31.31	2.185	.036	*
	Backward	2.29	1.09	.84	1.20	33.37	4.285	.001	**
	Syllables	3.67	3.22	.64	.42	61.58	3.464	.001	**
	Total Span	9.47	7.22	.50	2.15	23.28	4.485	.001	**
Inconstant	Forward	3.41	3.20	.51	.41	29.84	1.299	.203	NS
	Backward	2.00	2.33	1.96	.90	29.96	-.962	.343	NS
	Syllables	3.41	3.47	.51	.64	25.55	-.267	.791	NS
	Total Span	8.82	9.00	1.47	1.36	29.91	-.353	.726	NS
Grade One	Forward	3.50	3.03	.72	1.00	60.47	2.546	.013	**
	Backward	2.21	1.58	.91	1.24	61.14	2.171	.008	**
	Syllables	3.60	3.32	.61	.53	87.54	2.434	.016	*
	Total Span	9.29	7.92	1.51	2.06	61.33	3.557	.001	**

"t'" is a Welch approximation

**$p < .01$

*$p < .05$

It may be seen from Table 6.6 that in Kindergarten high discriminator mean scores of 3.02 on memory span for letters forward and 1.70 on memory span for letters backward are greater than low discriminator means of 2.54 for letters forward and .69 for letters backward. These findings reveal that as a group low discriminators in Kindergarten have shorter memory spans than high discriminators and have not acquired a memory span for letters backward. In the total Grade One sample, mean scores of high discriminators are also higher than means of low discriminators. As in Kindergarten, in Grade One the greatest difference between mean scores of 2.21 and 1.58 ($p < .01$) for letters backward favors high discriminators. Although differences between mean scores of the Inconstant group are not significant, means of low discriminators, with the exception of letters forward, are greater than high discriminators in the same group and greater in all memory span tests than low discriminators in other groups. It may be that while low discriminators in the Inconstant group attended successfully to auditory memory span items, they may not have developed the attention span required for performance on the longer auditory discrimination test, the SNADT.

Comparisons of mean scores of subjects in the Constant group show that means of 3.53 for letters forward and 2.29 for letters backward are greater than those of high discriminators in other groups indicating that subjects in Grade One with consistently high auditory discrimination ability have greater auditory memory spans. As Robinson (1946) has remarked that children in learning to read should have a memory span of at least three, it is possible that subjects with

consistently high auditory discrimination ability having an auditory memory span of three for letters forward and a span of two for letters backward may be more successful in learning to read. At the same time, it is also possible that subjects with short memory spans of less than three for memory for letters forward and less than two for memory for letters backward may have difficulty in learning to read.

Results of the auditory memory span tests in this study may be indicative of findings of other research workers in that the value of the memory span test lies in the differentiation of the upper and lower groups of the distribution. Perhaps the strength of the auditory memory span tests used in this study may be diagnostic as children with low auditory memory span scores will be detected early in Grade One.

II. Auditory Discrimination and Reading Achievement

The following sections report and discuss correlations between performance on the SNADT and oral and silent reading tests, results of a two-way analysis of variance showing the difference between good and poor oral and silent readers on the SNADT, and t-test results showing the difference between means on reading scores of high and low auditory discriminators.

Correlations between Performance on the SNADT and Reading Achievement

Correlation coefficients between results on the SNADT and scores on each of the silent and oral reading subtests are presented in Table 6.7.

TABLE 6.7

CORRELATIONS BETWEEN THE S-N AUDITORY DISCRIMINATION TEST AND READING ACHIEVEMENT TESTS IN GRADE ONE
N=100

Reading Test	Correlation with SNADT
Silent Reading	
Gates-MacGinitie	
Vocabulary	.415**
Comprehension	.441**
Oral Reading	
Neale Analysis	
Word Accuracy	.339**
Comprehension	.359**
Slosson	
Word Recognition	.335**

**$p < .01$

It may be seen from Table 6.7 that significant correlations of .415 ($p < .01$) and .441 ($p < .01$) exist between auditory discrimination and silent reading. The higher correlation .441 ($p < .01$) is between auditory discrimination and silent reading comprehension. Lower significant correlations of .339 ($p < .01$), .359 ($p < .01$) and .335 ($p < .01$) are reported between auditory discrimination and oral reading. These positive correlational

relationships between auditory discrimination and reading are in agreement with other studies which have attempted to assess the relationship of auditory discrimination ability to beginning reading (Reynolds, 1953; Deutsch, 1964; Dykstra, 1966; and Fast, 1968). Other studies (Cosens, 1968; Poling, 1968) have also reported that auditory discrimination ability is more closely related to silent reading achievement than to oral reading achievement. Unlike other studies, the significant positive correlations between auditory discrimination ability and reading achievement found in this study are specific to auditory discrimination of stop and nasal sounds, /p/, /t/. /k/. /b/, /z/, /d/, /g/, /m/, /n/, and /ŋ/ as measured by the SNADT in relation to beginning reading achievement of subjects in the middle of Grade One. It is possible that as ability to discriminate sounds facilitates ability to recode words, more attention is given to meanings of words. As a result, children with good auditory discrimination may read orally and silently with better comprehension.

Two-Way Analysis of Variance on Auditory Discrimination Scores

Two-way analysis of variance was used to test the difference between good and poor silent and oral readers on the SNADT. Subjects with silent reading comprehension scores above the Grade One mean of 1.8 are considered good silent readers, those below the mean are referred to as poor readers. Likewise, subjects with oral reading comprehension scores above the Grade One mean of 1.7 are referred to as good oral readers and those below the mean as poor oral readers. The results of the two-way analysis program are summarized in Table 6.8

TABLE 6.8

TWO-WAY ANALYSIS OF VARIANCE OF ORAL AND SILENT READING SCORES USING THE SNADT AS CRITERION

Source	Sum of Squares	DF	Mean Squares	F. Ratio	Probability	
SAB Oral Reading Silent Reading	.197	1	.197	.151	.697	NS
SE	.124552	96	.1297			
Oral Reading (a)	.3843	1	.3843	2.988	.087	NS
Silent Reading (b)	.10191	1	.10191	7.924	.005	**
SE	.124749	97	.1286			
Homogeneity of Variance Test - Chi-Sq..12 Prob. .004						

It may be seen from the probability .697 that interaction between silent and oral reading is not significant. There is a significant difference with a probability of .005 between good silent readers and poor silent readers due to the criterion score, auditory discrimination. Good silent readers are significantly different ($p < .01$) from poor silent readers in terms of their auditory discrimination scores on the SNADT. Although the probability .087 approaches significance, there was no significant difference between good oral readers and poor oral readers in this study due to auditory discrimination.

Comparisons Between High and Low Auditory Discriminator Groups on Reading Achievement

Table 6.9 reports differences between oral and silent reading achievement means of high and low auditory discriminator groups in Kindergarten and Grade One. It may be seen from Table 6.9 that reading achievement means of high discriminators in Kindergarten are significantly higher than low discriminators on subtests of the Gates-MacGinitie Reading Test ($p < .01$), the Neale Analysis of Oral Reading ($p < .01$) and the Slosson Oral Reading Test ($p < .01$). Mean grade scores of high discriminators are approximately five months greater than means of low discriminators. Like the mean scores of high discriminators in the Kindergarten group, the reading achievement means of the high discriminators in Grade One are also significantly superior to the low discriminators in silent reading and oral reading of words in isolation ($p < .01$) and word accuracy and comprehension in oral reading ($p < .05$).

Differences between oral and silent reading achievement means of high and low discriminators of the Inconstant group are not significant (Table 6.10). While the mean reading scores of both the high and low discriminators in this group are greater than the mean scores of low discriminators in other groups, means of high discriminators ranging from 1.3 to 2.0 are not so high as reading means ranging from 1.5 to 2.2 for high discriminators in the other groups. It may be seen from Table 6.10 that differences between reading achievement means of high and low auditory discriminators in the Constant group are significant. Reading mean scores of subjects who were high discriminators in

TABLE 6.9

MEANS AND STANDARD DEVIATIONS ON READING ACHIEVEMENT
OF HIGH AND LOW AUDITORY DISCRIMINATOR GROUPS
IN KINDERGARTEN AND GRADE ONE
N =100

Reading Test	Mean H.D.	Mean L.D.	S.Dev. H.D.	S.Dev. L.D.	Mean Adj.DF	t'	P	Sign
Kindergarten								
Gates-MacGinitie								
Vocabulary	22.10	15.62	7.24	4.54	97.97	5.496	.001	**
Comprehension	20.90	14.95	7.20	3.49	92.52	5.520	.001	**
Neale Analysis								
Word Accuracy	86.79 (2.2)	79.33 (1.6)°	8.07	14.61	52.99	2.914	.005	**
Comprehension	83.31 (1.9)	77.10 (1.4)	7.61	13.16	54.42	2.674	.009	**
Slosson	15.77	10.62	8.78	4.96	96.79	3.746	.003	**
Grade One								
Gates-MacGinitie								
Vocabulary	21.53	15.89	7.52	5.52	94.69	4.307	.001	**
Comprehension	21.53	15.13	8.59	3.73	90.21	5.131	.001	**
Neale Analysis								
Word Accuracy	85.81 (2.1)	79.05 (1.6)	11.63	14.75	64.87	2.401	.019	*
Comprehension	82.39 (1.8)	76.97 (1.3)	12.80	13.29	96.13	2.005	.048	*
Slosson	15.84	10.66	8.78	6.24	95.73	3.440	.001	**

"t'" is a Welch approximation

° Converted Grade Score

** $p < .01$

* $p < .05$

TABLE 6.10

MEANS AND STANDARD DEVIATIONS ON READING ACHIEVEMENT OF HIGH AND LOW AUDITORY DISCRIMINATORS IN CONSTANT AND INCONSTANT GROUPS IN GRADE ONE

Reading Test	Mean		S. Dev.		Mean			
	H.D.	L.D.	H.D.	L.D.	Adj.DF	t'	P	Sign
Constant Group								
Gates-MacGinitie								
Vocabulary	22.58	14.26	8.02	4.49	65.34	5.476	.001	**
Comprehension	22.18	13.96	9.23	3.48	62.28	5.929	.001	**
Neale Analysis								
Word Accuracy	86.38 (2.2)	76.43 (1.3)°	12.96	17.77	34.32	2.379	.023	*
Comprehension	83.16 (1.9)	74.96 (1.3)	14.80	16.64	40.12	1.994	.053	*
Slosson	16.76	9.35	9.33	4.22	65.33	4.503	.001	**
Inconstant Group								
Gates-MacGinitie								
Vocabulary	18.76	18.40	5.23	6.14	27.71	0.180	.857	NS
Comprehension	17.18	16.93	4.42	3.45	29.60	0.174	.783	NS
Neale Analysis								
Word Accuracy	84.29 (2.0)	83.07 (1.9)	7.11	7.09	29.53	0.488	.629	NS
Comprehension	80.35 (1.7)	80.07 (1.7)	4.00	3.83	29.78	0.207	.837	NS
Slosson	13.41	12.67	6.77	8.24	27.20	0.277	.783	NS

"t'" is a Welch approximation

° Converted Grade Score

** $p < .01$

* $p < .05$

Kindergarten and Grade one are significantly greater than mean scores of low discriminators in silent reading subtests ($p < .01$), oral reading of words in isolation, and oral word accuracy and comprehension subtests ($p < .05$). Results of the differences between reading achievement means of high and low discriminators in the Constant group show that subjects in Kindergarten who were high auditory discriminators and remained high auditory discriminators in Grade One are significantly superior readers in the middle of Grade One. At the same time, subjects in the Constant group who remained low discriminators are the poorer readers in the total test sample. It may be that Kindergarten children who retain high auditory discrimination ability in Grade One have an advantage over poor discriminators in the early stages of learning to read.

Analysis of test findings and observation of children's performance during the administration of silent and oral reading tests suggest that subjects in the study were going through various phases in the process of learning to decode words in beginning reading. As some children had to be tested individually or in very small groups, the investigator was able to observe these children very closely during silent reading and oral reading. It was observed by the investigator that while some children read with ease, other children read sight words, skipped words and attempted to sound out other words. The fact that the majority of Grade One children during silent reading were vocalizing and sounding out "letters" and words aloud may be indicative of the fact that articulation may be reinforcing auditory

discrimination by giving the child cues as to what the next sound should be. Thus the child, having already learned the phonology of the language, as in speaking, may be anticipating what sounds most likely will follow another sound. It was evident from observation that subjects who had attained a level of proficiency in blending sequences of sounds to decode words read fluenty and comprehensively. These children without actual formal training had developed the ability to associate a grapheme with a phoneme earlier than other children. It appeared that some children at an early stage in reading had grasped the concept that if you can utter the sounds of "letters" in sequence, you can say the words. Perhaps the subjects who are better oral readers as well as better silent readers learned to attend to differences in sequences of sounds in words earlier than other children and, therefore, when reading are more able to attend to meaning.

Correlation Coefficients Between Reading Achievement and Variables in the Study

Correlation coefficients were used to examine the relationship between oral and silent reading achievement and related variables in the study. Correlations are reported in Table 6.11 between reading achievement and the following variables: sex, chronological age, auditory acuity, auditory memory span, language in the home, intelligence and mental age. The low significant correlations of .218 to .227 ($p < .05$) between C.A. and performance on oral and silent word recognition subtests and of .245 to .379 ($p < .01$) between C.A. and performance on reading comprehension subtests indicate that older

TABLE 6.11

CORRELATIONS BETWEEN ORAL AND SILENT READING ACHIEVEMENT
AND RELATED VARIABLES IN THE STUDY
N=100

Variable	Silent Reading Gates Voc.	Silent Reading Gates Comp.	Oral Reading Neale W.A.	Oral Reading Neale Comp.	Oral Reading Slosson W.R.
Sex	.118	.180	.193	.189	.146
C.A.	.227*	.279**	.225*	.245**	.218*
Acuity	-.056	.004	.047	.037	.070
Memory Span	.318**	.367**	.432**	.394**	.276**
Language in Home	.390**	.314**	.332**	.264**	.276**
Intelligence	.578**	.562**	.553**	.541**	.440**
Mental Age	.627**	.598**	.592**	.593**	.496**

**$p < .01$

*$p < .05$

subjects in the study tend to have higher scores in oral and silent reading than younger subjects. While correlations of -.056 to .047 between auditory acuity and reading are negligible, significant correlations of .432 ($p < .01$) and .394 ($p < .01$) exist between oral reading and auditory memory span. Significant correlations of .318 and .367 ($p < .01$) are also reported between silent reading and auditory memory span. This finding indicates that there is a greater relationship between auditory memory span and oral reading than between

auditory memory span and silent reading. At the same time, higher correlations are reported between auditory discrimination and silent reading than between auditory discrimination and oral reading (Table 6.7). It may be that auditory discrimination is more closely related to silent reading achievement and auditory memory span to oral reading achievement. It may be seen from Table 6.11 that highly significant correlations of .440 to .578 ($p < .01$) are reported between reading achievement and intelligence. Correlation coefficients of .496 to .627 ($p < .01$) indicate even a greater relationship between mental age and oral and silent reading. These significant correlations between mental age and reading are markedly higher than other correlations and suggest that subjects in the study with the higher mental ages are the better readers.

III. AUDITORY DISCRIMINATION AND RELATED VARIABLES

This section reports findings of the study in relation to auditory discrimination ability as measured by the SNADT and the following variables: chronological age, sex, language environment and intelligence.

Chronological Age

Correlation coefficients reported in Table 6.12 show a slightly greater relationship between performance on the SNADT and C.A. in Kindergarten than in Grade One. The low significant correlation of .268 ($p < .01$) in Kindergarten compared to the lower correlation of .137 in Grade One suggests that as children become older there is less

correlation between auditory discrimination ability and C.A.

TABLE 6.12

CORRELATIONS BETWEEN THE SNADT AND C.A.
IN KINDERGARTEN AND GRADE ONE
N=100

Grade	Correlation with C.A.
Kindergarten	.268**
Grade One	.137

**$p < .01$

The significant difference between C.A. means of high and low auditory discriminators in Kindergarten reveals that older subjects in Kindergarten attained higher scores than younger subjects on the SNADT (Table 6.13). Although differences between C.A. means of high and low discriminators in Grade One are not significant, it may be seen from Table 6.13 that younger subjects in Grade One in the Constant group remained low discriminators. At the same time, means of high and low discriminators in the Inconstant group show not only that younger subjects who were low discriminators became high discriminators but also that older subjects in Kindergarten who were good discriminators have been designated low discriminators in Grade One. While this latter finding does not have statistical significance, it suggests that variables other than C.A. are operative in the development of auditory

discrimination ability during Grade One. In this study performance on the SNADT may have been influenced more by factors of learning than by C.A. Younger subjects, as in the Inconstant group, may be more attentive and as a result are developing greater attention spans and an awareness of what "to attend to" in listening to minimal word-pairs containing stop and nasal sounds.

TABLE 6.13

MEANS AND STANDARD DEVIATIONS ON C.A. OF HIGH AND LOW AUDITORY DISCRIMINATORS IN KINDERGARTEN AND GRADE ONE

Group	Mean		S. Dev.		Mean			
	H,D.	L.D.	H.D.	L.D.	Adj.DF	t'	P	Sign
Kindergarten	71.56	69.31	3.46	2.99	89.39	3.447	.001	**
Constant	76.50	75.22	6.34	3.06	65.87	1.212	.229	NS
Inconstant	75.88	77.47	3.02	3.46	28.04	-1.371	.181	NS
Grade One	76.40	76.11	5.61	3.37	97.98	.332	.740	NS

"t'" is a Welch approximation

** $p < .01$

Sex

In discussing the characteristics of the sample, it was reported that no significant differences existed between the mean auditory discrimination score of 199.13 for boys and 198.17 for girls.

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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Differences between mean scores of high and low auditory discriminators in relation to sex as reported in Table 6.14 are not significant. Table 6.15 shows the number of boys and girls who were designated high or low discriminators on the basis of auditory discrimination scores on the SNADT in Kindergarten and in Grade One.

TABLE 6.14

MEANS AND STANDARD DEVIATIONS ON SEX OF HIGH AND LOW AUDITORY DISCRIMINATORS IN KINDERGARTEN AND GRADE ONE

Group	Mean		S.Dev.		Adj.DF	Mean t'	P	Sign
	H.D.	L.D.	H.D.	L.D.				
Kindergarten	1.44	1.54	.50	.51	80.62	-0.929	.355	NS
Constant	1.51	1.34	.50	.48	63.22	1.639	.108	NS
Inconstant	1.49	1.57	.51	.51	44.33	-0.588	.559	NS
Grade One	1.41	1.21	.51	.46	29.98	0.850	.401	NS

"t'" is a Welch approximation

It may be seen from Table 6.15 that in Kindergarten twenty boys were low discriminators and twenty girls were low discriminators. While ten of the twenty boys who were low discriminators in Kindergarten became high discriminators in Grade One, eleven of the high discriminators in Kindergarten became low discriminators in Grade One; whereas only seven

of the girls who were low discriminators became high discriminators in Grade One and only four of the high discriminators became low discriminators. As there are twenty-one boys in the Inconstant group and only eleven girls, more boys changed in performance on the SNADT than girls.

TABLE 6.15

NUMBER OF HIGH AND LOW DISCRIMINATORS IN AUDITORY DISCRIMINATION GROUPS ACCORDING TO SEX IN KINDERGARTEN AND GRADE ONE
N=100

Group	Boys N=52		Girls N=48		Total Group N=100	
	H.D.	L.D.	H.D.	L.D.	H.D.	L.D.
Kindergarten	32	20	28	20	60	40
Constant	21	10	24	13	45	23
Inconstant	10	11	7	4	17	15
Grade One	31	21	31	17	62	38

Language Environment

In this study language environment is considered in relation to the child's position in the family, the number of children in the family and the language of parents in the home. To detect any significant relationships between performance on the SNADT and language environment in the home, correlation coefficients were examined.

Low correlations of -.045 and .007 between auditory discrimination and position in family and number in family are reported in

Table 6.16. The low negative correlation of -.045 between auditory discrimination and position in the family shows a very slight tendency for younger subjects in the family to have better auditory discrimination in Grade One than older subjects in a family. As the significant positive correlation of .335 ($p < .01$) indicates a relationship between language spoken in the home and auditory discrimination, results of t-tests were used to examine differences between language means of high and low discriminators.

TABLE 6.16

CORRELATIONS BETWEEN THE SNADT AND LANGUAGE ENVIRONMENT IN THE HOME IN GRADE ONE
N=100

Language Environment	Correlation with SNADT
Position in family	-.045
Number in family	.007
Language in home	.335**

**$p < .01$

Table 6.17 reports significant differences between language means of low and high auditory discriminators in the Constant group ($p < .01$) and Grade One ($p < .01$) favoring subjects in the English language environment. It may be seen from Table 6.18 that high discriminators and low discriminators are in English language environment groups as well as in Non-English groups. Table 6.18 shows there

TABLE 6.17

MEANS AND STANDARD DEVIATIONS ON LANGUAGE IN THE HOME OF HIGH AND LOW AUDITORY DISCRIMINATORS IN GRADE ONE
N=100

Group	Mean H.D.	Mean L.D.	S.Dev. H.D.	S.Dev. L.D.	Adj.DF	Mean t'	P	Sign
Constant	1.84	1.39	.37	.50	37.49	3.856	.005	**
Inconstant	1.71	1.60	.47	.51	28.78	.610	.546	NS
Grade One	1.81	1.47	.40	.51	64.77	3.451	.001	**

"t'" is a Welch approximation

** $p < .01$

TABLE 6.18

NUMBER OF HIGH AND LOW DISCRIMINATORS IN AUDITORY DISCRIMINATION GROUPS ACCORDING TO LANGUAGE IN THE HOME IN KINDERGARTEN AND GRADE ONE
N=100

Group	Eng. Env. N=68		Non-Eng. Env. N-32		Total Group N=100	
	H.D.	L.D.	H.D.	L.D.	H.D.	L.D.
Kindergarten	46	22	14	18	60	40
Constant	37	9	8	14	45	23
Inconstant	13	9	4	6	17	15
Grade One	50	18	12	20	62	38

are 22 low discriminators in Kindergarten constituting 35 per cent of the English language environmental group compared to 18 low discriminators constituting 56 per cent of the Non-English group. In Grade One 18 subjects or 26 per cent of the English group are low discriminators compared to 20 low discriminators or 62 per cent of the Non-English group. Therefore, a greater percentage of subjects from Non-English language environments than from English environments in this study are low discriminators in Kindergarten and Grade One. The finding that a greater percentage of subjects in the Non-English group are low discriminators may indicate that subjects from such environments may develop more slowly in acquiring the ability to distinguish differences in English sounds. As low discriminators in the Constant group have the lowest C.A. mean (Table 6.13), it is also possible that performance was influenced by C.A. of the low discriminators in the Non-English group. Further analysis of Table 6.18 reveals that 7 or one-half of the 14 low discriminators in the Constant group were in bilingual classes and 3 or one-half of the 6 low discriminators in the Inconstant group were in bilingual classes. The fact that as many Non-English subjects in regular classrooms as in bilingual classes are low discriminators reveals that factors other than classroom environments for Non-English subjects are important in discriminating stop and nasal sounds.

While it is possible that administration of the SNADT required subjects from Non-English language environments to attend to

differences in sounds more attentively than other subjects in the study, comparisons of subjects in the Constant and Inconstant group, as well as the fact that there are high and low auditory discriminators in English and Non-English groups, suggest that there are fundamental factors of C.A., attention and set common to both English and Non-English groups in discriminating word-pair items on the SNADT.

Intelligence

Correlations between intelligence and performance on the SNADT are reported in Table 6.19.

TABLE 6.19

CORRELATIONS BETWEEN THE SNADT AND INTELLIGENCE FACTORS IN GRADE ONE
N=100

Intelligence Factor	Correlation with SNADT
Logical Reasoning	.263**
Numerical Reasoning	.312**
Verbal Comprehension	.375**
Delayed Memory	.347**
Intelligence Quotient	
Language	.407**
Non-Language	.301**
Total	.390**
Mental Age	.417**

**$p < .01$

It may be seen from Table 6.19 that significant correlations ranging from .263 to .417 ($p < .01$) exist between auditory discrimination ability and intelligence as measured by the California Short-Form Test of Mental Maturity. The highest correlation .417 ($p < .01$) is reported between M.A. and auditory discrimination. Examination of the four factors of intelligence measured, namely logical reasoning, numerical reasoning, verbal comprehension and delayed memory reveals a slightly higher correlation of .375 ($p < .01$) between verbal comprehension and auditory discrimination. The correlation of .407 ($p < .01$) indicating the relationship between the Intelligence Quotient for language scores and auditory discrimination suggests a greater relationship between ability to comprehend verbal concepts and auditory discrimination than between ability to analyze logically concepts and relationships and auditory discrimination. As abilities measured by the language section of the test are generally more related to classroom activities in Grade One than those measured by the non-language section, this finding reflects to a certain extent the influence of school environment on the language development of the child.

Results of t-tests indicate significant differences between mean intelligence scores of high and low discriminators in Grade One (Table 6.20). Although no significant difference exists between the C.A. of 76.40 and 76.11 (Table 6.13) for high and low discriminators in Grade One, there is a significant discrepancy of eight months between the mean M.A.'s of 85.69 and 77.63 ($p < .01$). While the high discriminator M.A. mean of 85.69 is nine months greater than the C.A.

mean of 76.40, the M.A. mean of 77.63 of low discriminators shows that their performance on the intelligence test is at a level equal to or a month greater than that of the normal child of the same C.A. of 76.11.

TABLE 6.20

MEANS AND STANDARD DEVIATIONS ON INTELLIGENCE
OF HIGH AND LOW AUDITORY DISCRIMINATORS
IN GRADE ONE
N=100

Factor	Mean		S.Dev.		Adj.DF	Mean t'	P	Sign
	H.D. N=62	L.D. N=38	H.D.	L.D.				
Logical Reasoning	25.81	23.08	5.41	4.9]	84.07	2.589	.001	**
Numerical Reasoning	14.18	11.87	3.15	3.06	80.26	3.620	.001	**
Verbal Comprehension	17.71	15.29	3.28	3.94	67.75	3.173	.002	**
Delayed Memory	8.50	6.50	2.87	2.72	81.71	4.274	.001	**
I.Q. Language	110.47	99.29	13.07	10.61	90.40	4.673	.001	**
Non-Language	112.21	104.79	12.72	9.57	93.78	3.312	.001	**
Total I.Q.	112.16	102.03	12.84	9.35	95.00	4.551	.001	**
Mental Age	85.69	77.63	9.15	7.83	87.60	4.684	.001	**

"t'" is a Welch approximation

**$p < .01$

M.A. means of 79.18 and 81.80 of high and low discriminators in the Inconstant group are also greater than the C.A. means of 75.88 and 77.47. While there is a difference of two months between M.A. means favoring low discriminators, both high and low discriminators in the Inconstant group performed at a level equal to that of a normal child chronologically four months older. It may be seen from Table 6.21 that the only significant difference between means of high and low discriminators in the Inconstant group is in the logical reasoning subtest ($p < .05$). While this may reveal that low discriminators in this group have ability to perceive relationships between objects visually presented better than high discriminators of the same group, the lower mean for delayed recall may indicate that low discriminators in the Inconstant group with low retentive ability have not developed an ability to attend to verbally presented material with sustained attention for any length of time.

Table 6.22 reports significant differences between means on intelligence subtests ($p < .01$), intelligence quotients ($p < .01$) and mental ages for consistently high and low discriminators in the Constant group. It may be seen from Table 6.22 that the mean intelligence score 114.98 of consistently high discriminators is greater than the I.Q. mean of 112.16 of high discriminators in the total Grade One group and the mean of 104.71 of the high discriminators in the Inconstant group. Likewise, the I.Q. mean of 99.30 of consistently low discriminators in the Constant group is lower than I.Q. means of the other groups. Like the total Grade One group and the

TABLE 6.21

MEANS AND STANDARD DEVIATIONS ON INTELLIGENCE OF HIGH AND LOW AUDITORY DISCRIMINATORS IN THE INCONSTANT GROUP
N=32

Factor	Mean		S.Dev.		Mean			
	H.D. N=17	L.D. N=15	H.D.	L.D.	Adj.DF	t'	P	Sign
Logical Reasoning	21.47	25.07	5.64	4.37	29.55	-2.030	.051	*
Numerical Reasoning	13.00	13.00	3.37	2.00	26.59	.000	1.000	
Verbal Comprehension	16.12	17.13	3.77	2.23	26.45	- .939	.356	NS
Delayed Memory	7.24	6.80	2.95	2.65	29.98	.331	.663	NS
I.Q. Language	104.76	103.13	12.96	9.87	29.42	.403	.689	NS
Non-Language	104.29	109.67	11.09	10.36	29.89	-1.417	.166	NS
Total I.Q.	104.71	106.20	11.97	8.63	28.93	- .408	.686	NS
Mental Age	79.18	81.80	7.99	6.14	29.50	-1.048	.303	NS

"t'" is a Welch approximation

*$p < .05$

Inconstant group, the difference of 1.28 between C.A. means of 76.50 and 75.22 of the Constant group is not significant. The difference between M.A. means of 88.16 of high discriminators and of 74.99 of low discriminators with a wide discrepancy of a year and two months is significant ($p < .01$). The lower M.A. of 74.99 of the consistently low discriminators reveals that subjects in this group are chronologically and mentally younger than subjects in other discrimination groups.

TABLE 6.22

MEANS AND STANDARD DEVIATIONS ON INTELLIGENCE
OF HIGH AND LOW AUDITORY DISCRIMINATORS IN
THE CONSTANT GROUP
N=68

Factor	Mean H.D. N=45	Mean L.D. N-23	S.Dev. H.D.	S.Dev. L.D.	Adj.DF	Mean t'	P	Sign
Logical Reasoning	27.44	21,78	4.36	4.92	39.98	4.665	.001	**
Numerical Reasoning	14.62	11.13	2.99	3.43	39.41	4.146	.001	**
Verbal Comprehension	18.31	14.09	2.90	4.37	32.20	4.190	.001	**
Delayed Memory	8.98	5.57	2.73	2.71	44.66	4.920	.001	**
I.Q. Language	112.62	96.78	12.59	10.53	52.03	5.484	.001	**
Non-Language	115.20	101.61	12.09	7.69	62.69	5.637	.001	**
Total Language	114.98	99.30	12.12	8.94	57.41	6.037	.001	**
Mental Age	88.16	74.91	8.38	7.72	47.82	6.502	.001	**

"t'" is a Welch approximation

** $p < .01$

With the exception of the similar I.Q. mean of 104 of high discriminators in the Inconstant group, non-language I.Q. means of both high and low discriminators are greater than language I.Q. means. This finding indicates that high and low discriminators attained higher scores in perception of opposite, similar and analogic

relationships visually presented than in comprehension and recall of details verbally presented. As abilities measured by the language section are generally regarded to be more related to language activities carried out in a classroom situation and as high discriminators have higher I.Q. language means than low discriminators, it is possible that high discriminators performance may have been affected by learning. It may be that high discriminators attained higher scores than low discriminators as they have learned to listen attentively to verbally presented stimuli and as a result have developed greater powers of attention, concentration and retention than low discriminators.

Summary

This chapter reported further analysis of the findings in relation to auditory discrimination, reading achievement and variables investigated in the study. Statistical analysis showed significant growth and development in auditory acuity ($p < .01$) and auditory memory span ($p < .01$) of subjects in the study from Kindergarten to Grade One. While low correlations between auditory acuity and auditory discrimination were not significant, correlations between auditory memory span and auditory discrimination were significant ($p < .01$), thereby revealing a significant relationship between the sounds the subjects in the study could discriminate and the sequences of sounds the subjects could retain and recall.

Significant correlations ranging from .335 to .442 ($p < .01$) were reported between reading achievement and auditory discrimination,

and correlations ranging from .276 and .432 ($p < .01$) were reported between reading achievement and auditory memory span. The highly significant correlation of .441 ($p < .01$) between silent reading achievement and auditory discrimination suggests a greater relationship between silent reading and auditory discrimination than between oral reading and auditory discrimination. At the same time, the correlation .432 ($p < .01$) between oral word accuracy and auditory memory span indicates a stronger relationship between oral reading and auditory memory span.

Further statistical analysis revealed that subjects who were consistently high auditory discriminators with above average intellectual ability were better readers in Grade One, and subjects who were consistently low discriminators with average intellectual ability were poorer readers. Mean reading scores of subjects in the Inconstant group with average intelligence who were not consistent in performance on auditory discrimination tasks revealed that these subjects were average readers. The conclusions, implications and recommendations from these findings will be presented in the next chapter.

CHAPTER 7

SUMMARY, CONCLUSIONS AND IMPLICATIONS

It was the primary purpose of this study to investigate development in the ability of Kindergarten and Grade One subjects to discriminate auditorily stop and nasal sounds in specified vowel environments and to ascertain the effect auditory discrimination ability has on beginning reading achievement. A brief summary of the study together with the conclusions drawn from the findings, the educational implications arising from the study and suggestions for further research are presented in this chapter.

I. SUMMARY OF THE STUDY

The initial investigation began in May, 1970 and included 114 Kindergarten subjects enrolled in 6 classes in 3 different schools. During the intervening six months, from Kindergarten to Grade One, the test sample decreased from 114 to 100 subjects. The 100 Grade One subjects remaining in the test sample were enrolled in 25 classrooms in 16 different schools. Complete data were gathered on 52 boys and 48 girls.

As it was important to the study to appraise the ability of Kindergarten and Grade One children to discriminate fine differentiations in stop and nasal sounds, an auditory discrimination test was constructed. Prior to the main study, a pilot study involving 12 children from a private Kindergarten class was conducted. The primary

purpose of the pilot study was to administer the original form of the auditory discrimination test in order to practise administration and scoring procedures, to examine the statistical analysis and to determine desirable refinements in the test. Results obtained from the initial administration of the auditory discrimination test were subjected to a test item analysis computer program. On the basis of the difficulty indexes and biserial correlations of the item analysis, word-pair items were retained or eliminated from the test. The revised form of the research instrument, the S-N Auditory Discrimination Test, was used to assess the auditory discrimination ability of subjects in the main study. The item analysis program in the main study served to establish the reliability and validity of the test.

All auditory tests, namely the Maico F1 audiometric, the S-N Auditory Discrimination Test, the Auditory Memory Span for Letters Test and the Auditory Memory Span for Syllables Test were administered individually to subjects during their final month in Kindergarten and six months later in Grade One. In addition, standardized tests of mental maturity and oral and silent reading were administered to the subjects in Grade One. Information concerning the linguistic aspects of the home environment of the child and other pertinent data were obtained from cumulative record cards in the school.

Data collected were treated and and by means of a variety of statistical procedures, the growth and development of auditory abilities was examined, difficulty of stop and nasal sounds in varied phonemic environments was investigated and the relationship between auditory discrimination and reading achievement as well as between auditory discrimination and other variables was determined.

II. SUMMARY OF CONCLUSIONS

The developmental aspects of auditory abilities of young children and the relationship between auditory discrimination, reading achievement and other factors identified in the study are summarized below according to the questions posed in the study and the null hypotheses.

Question 1

> Does the phonemic environment of stop and nasal sounds facilitate the auditory discrimination of these sounds?

Findings indicate that in the third month of Grade One children have not mastered the ability to discriminate auditorily between stop sounds and between nasal sounds in varied phonemic environments. Analysis of word-pair items revealed children had less difficulty in recognizing like word-pair items than unlike word-pair items. In examining word-pair items, it was noted that 24 per cent of the 68 items containing bilabial-alveolar sound contrasts, /p/-/t/, /b/-/d/ and /m/-/n/, were among the most difficult for subjects to discriminate, 9 per cent of the 55 alveolar-velar contrasts, /t/-/k/, /d/-/g/ and /n/-/ŋ/, and 5 per cent of the 39 bilabial-velar /p/-/k/, /b/-/g/ and /m/-/ŋ/. In considering difficulty of sound contrasts in relation to place of articulation, findings revealed that children in the third month of Grade One found bilabial-alveolar contrasts more difficult to discriminate than alveolar-velar contrasts and alveolar-velar contrasts more difficult than bilabial-velar contrasts. In considering manner of articulation voiced contrasts were among the most difficult word-pair items and among the least difficult. Therefore, it appeared that

discrimination of word-pair items was not only dependent upon the place and manner of articulation of the sound contrasts but also on the position of the sound in the word. In considering the position of the sound, unlike word-pair items were more difficult to discriminate when the stop or nasal sound contrast was in final position.

As nasal contrasts were more difficult to discriminate than stop contrasts, it may be concluded that there are children in Grade One who have not mastered the consonant-sonorant distinction necessary for auditory discrimination of nasals within the context of vowel sounds. While analysis of sound contrasts showed greater gains from Kindergarten to Grade One in the subjects' ability to discriminate nasal contrasts /m/-/n/ following high and mid front vowels, /i/, /e/, /ɛ/, findings revealed that 40 per cent of Grade One subjects were still experiencing difficulty in discriminating the nasal contrast. The least gain in performance was indicated by the 52 per cent of the Grade One subjects experiencing difficulty with the bilabial-alveolar nasal contrasts /m/-/n/ following the mid back vowel /o/. Analysis also revealed that while 36 per cent of the sample had difficulty discriminating voiced alveolar-velar contrasts /d/-/g/ following the low back vowel /ɔ/, 32 per cent of the subjects also had difficulty discriminating the bilabial-velar sound contrast /b/-/g/ following the center and low back vowels /ə/, /ɔ/.

Findings of this study neither substantiate nor contradict other research studies with respect to conclusions concerning difficulty of sound contrasts in minimal word-pair items but are supportive of the hypothesis that phonemic environment affects the discriminability of stop and nasal sound contrasts. As young children in speech

attend to the gestalt or listen to words in context to anticipate following words, results of this study may indicate that young children in the early part of Grade One are not aware of the importance of attending to sequences of sounds within words in order to discriminate minimal word-pairs and as a result tend to anticipate sounds, particularly final sounds. Therefore, it may be concluded that while the environment of stop and nasal sounds facilitates auditory discrimination of these sounds, it also appears that children progress through various levels or stages in the development of auditory discrimination ability not only in general but with respect to specific sound sequences.

Question 2

> Does a developmental pattern exist in the ability of Kindergarten and Grade One children to discriminate stop and nasal sounds?

Results of this study, while revealing the interrelatedness of features of sound, suggest a spiral effect operating in the ability of Grade One children to discriminate stop and nasal sound contrasts. It would appear that while children are becoming consistent in their ability to discriminate between bilabial consonants and velar consonants, that is, between front consonants and back consonants, between front vowels and back vowels, and high and low vowel sounds, they are still experiencing difficulty in making the finer and yet gross differentiations between contrasts such as those involving alveolar sounds and sounds in the environment of a mid back vowel.

While results of this study are not definitive and suggest, as in other aspects of development, spurts and plateaus in auditory discrimination of stop and nasal sound contrasts, it may be assumed that

auditory discrimination sequencing is orderly in that the greatest possible discriminations are made first, with finer discriminations following later. As phoneme sequencing is orderly, it is possible that Jakobson and Halle's model (1956) could be used as a basis for a theoretical model for sequencing in auditory discrimination.

Null Hypothesis 1

> There is no significant difference between the ability of Kindergarten children to make auditory speech discriminations and the auditory discrimination ability of these same children when tested six months later in Grade One.

As revealed by total test scores on the S-N Auditory Discrimination Test, auditory discrimination ability of subjects in the test sample increased consistently from Kindergarten to Grade One. Statistical analysis of the data indicated significant differences at the .01 level between auditory discrimination mean scores of subjects in Kindergarten and Grade One. On the basis of this finding the null hypothesis was rejected.

The general increase in the ability of children from Kindergarten to Grade One to discriminate sound contrasts included in the S-N Auditory Discrimination Test supports the theory of the developmental nature of auditory discrimination ability in young children. In addition, prior to initial reading achievement, children during their first three months in Grade One can be expected to develop in ability to discriminate auditorily finer differentiations of stop and nasal sounds within specified phonemic environments.

Null Hypothesis 2

> There is no significant difference between the auditory acuity of Kindergarten children as measured by the Maico

F1 audiometer and the acuity of these same children when tested six months later in Grade One.

Differences between auditory acuity mean scores of subjects in Kindergarten and Grade One on low, middle and high frequencies were statistically significant at the .01 level. The progressive increase in hearing acuity of Grade One subjects was shown by the statistically significant ($p < .01$) decrease in mean scores indicating a decrease in decibel loss or increase in hearing acuity of subjects from Kindergarten to Grade One. Therefore, the null hypothesis was not upheld.

Comparison of performance of Grade One children with their performance in Kindergarten revealed that approximately 25 per cent of the children in Kindergarten, having audiograms with minus 20 decibel losses, had not attained an accepted standard of satisfactory acuity compared to only 7 per cent of these same children in Grade One. While this implies the need for research to determine interpretation of children's audiograms reporting so-called decibel losses, it also reveals that children's acuity improves with age. It can be expected that Grade One children becoming familiar with an audiometric test, knowing what to attend to, listen more attentively and respond in a less hesitant and more efficient manner. As a result, it is difficult to separate the effect of learning and experience from the process of maturation. The finding that children's acuity increased over a six month period of time supports research studies reporting the developmental nature of auditory acuity and indicating the effect of factors of maturation and learning on auditory acuity of young children.

While children in Grade One acquire a proficiency in responding to auditory acuity stimuli in a testing situation for pure tones

of low, middle and high frequencies, it can be expected that all children will not attain the same level of acuity. Results of this study stress the importance of reassessing young children's auditory acuity particularly during the first year of school to determine maturational development or actual loss of acuity which may interfere with the acquisition of language and hence impede progress in learning to read in Grade One.

Null Hypothesis 3

> There is no significant difference between the auditory memory spans of Kindergarten children and the auditory memory spans of these same children when tested six months later in Grade One as indicated by:
> a. total memory span scores
> b. subtest scores measuring
> (1) memory for letters forward
> (2) memory for letters backward
> (3) memory for syllables.

The mean total scores of auditory memory span for subjects in the test sample showed a slight progressive increase in performance of subjects over a period of six months from Kindergarten to Grade One. Differences between total auditory memory span scores in Kindergarten and Grade One were statistically significant at the .01 level. Thus, the portion of the null hypothesis pertaining to total memory span was rejected.

The differences between subtest scores measuring memory for letters forward and memory for letters backward were statistically significant at the .01 level. Although the Grade One mean score on the auditory memory syllable span subtest slightly exceeded the Kindergarten mean score, the difference was not significant. Consequently, the portion of the null hypothesis pertaining to memory span for letters

was rejected and the portion pertaining to auditory memory span for syllables was upheld.

As early as 1946, Robinson, in reference to children having problems with reading, suggested that children to be successful in learning to read should have an auditory memory span of at least three. However, although it has been pointed out that a short auditory memory span is reflected in an inability to master word recognition techniques (Betts, 1957) and research studies have attempted to find the relationship between auditory memory span and reading, little attempt has been made to examine auditory memory spans of pre-school and primary school children to determine the magnitude of the auditory memory span required for success in beginning reading. The statistical analysis of data in this study, revealing a mean score of three for auditory memory span for letters forward and for syllables, and a mean score of two for letters backward, may be indicative of an adequate auditory memory span for success in beginning reading for children in their third month in Grade One.

The small increase in auditory memory span of Grade One children reveals a slower and less apparent development in auditory memory span in comparison to development of auditory acuity and auditory discrimination. Eagan (1970) in reporting developmental aspects of auditory memory span for digits and syllables also indicated slower rate of development. This slow development may be explained in terms of a levelling-off process, of a plateau in development. It is possible that Grade One children, as in this study, are developing an auditory memory span for syllables within this level of auditory perception. That is, in attending to auditory memory span for syllables, children's

responses, particularly as they become more aware of language and aware of a process of reading, are influenced by language factors of auditory blending. Thus, children during Grade One become aware of blending sequences of phonemes into syllables and syllables into words.

Null Hypothesis 4

> There is no significant relationship between auditory discrimination ability of children and
> a. chronological age
> b. sex
> c. position in the family
> d. number of siblings in the family
> e. language environment in the home
> f. auditory acuity
> g. auditory memory span
> h. intelligence.

Statistical analysis of data showed that chronological age correlated with auditory discrimination ability at the .01 level in Kindergarten. In Grade One correlations between chronological age and auditory discrimination ability were not significant. Consequently, the portion of the hypothesis which pertained to the variable of age could not be totally rejected.

While older subjects in the present study tended to attain higher scores in auditory discrimination ability in Kindergarten than younger subjects, in Grade One analysis of the data seemed to indicate that as children progress through Grade One and improve in auditory discrimination ability, the relationship between auditory discrimination and chronological age is less clear cut.

Differences between the mean auditory discrimination scores of boys and girls were not significant. Thus, the portion of the hypothesis pertaining to the variable of sex was upheld. The findings in

this study that the auditory discrimination mean score of boys, although not significant, was slightly higher than the auditory discrimination mean score of girls supports the research of Cosens (1968), Poling (1968), and Oberg (1970). Boys, at times, then, can be expected to obtain scores in auditory discrimination which are as high or possibly higher than those of girls. As many of the recent research studies do not show significant differences between auditory discrimination performance of boys and girls, as did several earlier studies, it is probable that the variable of sex is of little significance for a general theory of auditory discrimination development.

In analyzing factors relevant to the linguistic environment in the home, statistical analysis revealed non significant correlations between auditory discrimination and number of siblings in the family as well as between auditory discrimination and position of the child in the family. Correlations between auditory discrimination and language environment in the home were significant. As a result, the portion of the null hypothesis which pertained to the variables of home environment was partially rejected.

As a greater percentage of children from English language environments tended to attain higher scores on the <u>S-N Auditory Discrimination Test</u> than children from Non-English language environments, it is possible that the administration of auditory discrimination tests make greater demands on the attention spans of children from Non-English environments. It is also possible that subjects from a Non-English environment may develop more slowly in attending to and in becoming aware of the fine differences in English speech sounds. Although not statistically significant, from further analysis of data

with respect to auditory discrimination ability of high and low discriminators, common factors of chronological age, attention span and set can be considered to be important for Grade One children from both English and Non-English language environmental groups in discriminating stop and nasal sound contrasts. At the same time, it is also probable that Grade One children from a Non-English speaking environment with adequate auditory acuity may not have learned the phonology relative to English phonemes. Thus, while children of both English and Non-English language environmental groups may still possess childish traits, the child from the Non-English environment not having acquired the phonological system of his mother tongue has yet another problem in not having acquired the phonological system of English.

The low negative correlations reported between auditory discrimination and auditory acuity were not statistically significant. Therefore, the portion of the hypothesis pertaining to the variable of auditory acuity was upheld. The slightly greater relationship between auditory discrimination and auditory acuity in Kindergarten suggests that as children become older and progress through Grade One auditory discrimination ability is less dependent on auditory acuity and may be affected more by the ability of the child to sustain attention for a length of time and by the awareness of the child in knowing what to attend to in discriminating speech sounds.

Significant relationships at the .01 level existed between auditory memory span and auditory discrimination. Accordingly, the portion of the hypothesis which pertained to the variable of auditory memory span was rejected. Many researchers have investigated auditory discrimination and auditory memory span in relation to reading

achievement, but few researchers have attempted to show the relationship between these two auditory abilities. Findings of this study showing a definite relationship between auditory discrimination and auditory memory span of young children concur with those of Eagan (1970). It may be concluded that there is a relationship between what the child is able to discriminate and what he can remember in sequence.

Correlations between pupil performance on the auditory discrimination test and the intelligence test were significant at the .01 level. Therefore, the portion of the hypothesis pertaining to intelligence was rejected. In general, research studies have concluded that while auditory discrimination has intellectual components, it cannot be fully measured by intelligence. From the high correlations between auditory discrimination and intelligence in this study, it can be stated that pupils with high intelligence performed better than pupils with lower intelligence on the S-N Auditory Discrimination Test. This positive relationship between auditory discrimination and intelligence substantiates research of Thompson (1961) and Poling (1968) indicating that adequacy in auditory discrimination is frequently accompanied by adequacy in intelligence at the beginning of the first year of school. Factors such as attention, concentration, interest and motivation may be the abilities common to both intelligence and auditory discrimination which influence the performance of the child in Grade One.

Null Hypothesis 5

There is no significant relationship between reading achievement and

a. chronological age
b. sex
c. auditory acuity
d. auditory discrimination

e. auditory memory span
f. intelligence
g. mental age.

Statistical analysis revealed that significant correlations existed between chronological age and oral and silent word recognition subtest scores at the .05 level and between oral and silent reading comprehension scores at the .01 level. Performance on oral and silent reading subtests indicate that older subjects in the study tend to have higher scores in oral and silent reading than younger subjects in Grade One. Therefore, the portion of the hypothesis which pertained to chronological age was rejected. More than likely age may be considered as a macrovariable that influences maturation which in turn is affected by the environment of the child and the child's ability and desire to learn.

As the low correlations between reading achievement and sex were not statistically significant, the portion of the hypothesis pertaining to the variable of sex was upheld. While correlation coefficients indicating the relationship between measures of reading achievement and sex were low and failed to reach significance, further statistical analysis revealed that differences between mean scores of boys and girls on oral reading tasks were significant ($p < .05$) and approached significance on comprehension of silent reading. Although there was little difference between mean scores of boys and girls on related auditory abilities, difference between auditory memory span for syllables favoring girls was significant ($p < .05$).

As has been suggested previously, performance on auditory memory span for syllables may be influenced by language factors relative to auditory perceptual development. While it is plausible that the

interaction of maturation and learning influenced by common auditory and language experiences during the first months in Grade One may serve to lessen the differences between sexes, it is possible that Grade One boys have not developed auditory memory span ability to the same degree as girls. Thus, it may be that girls, as a group, having developed auditory memory span ability to a greater extent than boys, perform better than boys on oral and silent reading tasks.

Correlations between auditory acuity scores and reading achievement were not statistically significant. Therefore, the portion of the hypothesis pertaining to auditory acuity was upheld. Results of this study showed that 93 per cent of the Grade One children had attained an accepted standard of satisfactory acuity. It may be concluded then that auditory acuity is not the cause for children in Grade One being poor readers.

The relationship between oral and silent reading achievement scores and auditory discrimination ability were statistically significant at the .01 level. As a result the portion of the null hypothesis pertaining to auditory discrimination ability could not be upheld. It may be stated then that children in the third month of Grade One with good auditory discrimination ability can be expected to perform better in initial reading achievement than children with poor auditory discrimination ability.

Statistical analysis of the data also indicated significant correlations at the .01 level between oral and silent reading achievement and auditory memory span, and thereby indicates that Grade One children with high auditory memory spans can be expected to perform significantly better on oral and silent reading than children with low

auditory memory spans. Consequently, the portion of the hypothesis pertaining to the variable of auditory memory span was rejected.

Further analysis of data revealed a greater relationship between silent reading and auditory discrimination than between oral reading and auditory discrimination. At the same time, statistical analysis also revealed higher correlations between auditory memory span and oral reading than between auditory memory span and silent reading.

It appears that auditory discrimination and auditory memory span are interrelated and are both essential to initial achievement in reading. While both auditory discrimination ability and auditory memory span are related to oral and silent reading, it is possible that in reading orally Grade One children, as they hear themselves read, are able to anticipate the sound patterns of the language they are accustomed to, and have less difficulty in decoding and in retaining and recalling sequences of sounds in words. In silent reading children, when beginning to learn to read, are not reinforced through hearing the sound of the whole word and the language pattern of the sentence. Therefore, in silent reading it is important that children are able to discriminate sounds, to isolate a sound and to relate the sound to other sounds within its environment. Silent reading may be a more difficult task for Grade One children, as many of the words to be decoded are monosyllabic having less phonemic cues than polysyllabic words and thereby demand finer discriminations. It may be concluded then that children with better auditory discrimination ability and greater auditory memory spans have greater facility in decoding words and, therefore, can be expected to be better silent and oral readers.

Correlations between intelligence and oral and silent reading achievement were significant at the .01 level. As subjects with higher intelligence scores performed significantly better than pupils with lower intelligence scores on oral and silent reading subtests, the portion of the null hypothesis pertaining to the variable of intelligence could not be upheld.

From the statistical analysis of data it was evident that significant correlations ($p < .01$) between mental age and reading achievement indicate a greater relationship between reading achievement and mental age than between reading achievement and other variables in the study. Accordingly, the portion of the null hypothesis pertaining to mental age could not be upheld. While it can be concluded that children with higher mental ages are better readers, it remains to determine the underlying common factors which facilitate and affect the performance of young children in tasks of auditory discrimination, mental maturity and early reading.

Null Hypothesis 6

> High and low auditory discriminators in Kindergarten do not differ significantly in reading achievement in Grade One.

Statistical analysis of data revealed significant differences at the .01 level between the performance of high and low auditory discriminators in Kindergarten on oral and silent reading achievement tasks in Grade One. Therefore, the null hypothesis was rejected. Consequently, it appears that subjects who had above average auditory discrimination ability in Kindergarten were better readers in Grade One than subjects with lower auditory discrimination ability. Further analysis of the data indicated that high and low discriminators in

Kindergarten not only differed significantly in auditory discrimination ability and reading performance but also in factors of chronological age ($p < .01$) and auditory memory span ($p < .01$). As a group Kindergarten low discriminators were younger in age than high discriminators, had shorter auditory memory spans and had not acquired a memory span for letters backward. It may be concluded then that children entering Grade One differ significantly in chronological age, auditory discrimination ability and auditory memory span. The fact that children entering Grade One can be expected to manifest wide variation in adequacy of auditory discrimination and auditory memory span reveals the need for careful assessment of auditory abilities upon entrance to school to prevent failure in reading by providing profitable instructional programs early in the school year to develop and strengthen both auditory discrimination and auditory memory span.

Null Hypothesis 7

> High and low auditory discriminators in the third month of Grade One do not differ significantly in reading achievement in Grade One.

In the middle of Grade One significant differences in reading achievement were found between high and low auditory discriminators. These differences were in silent reading ($p < .01$) and oral reading ($p < .05$) and favored the high discriminators. As a result, the null hypothesis was rejected. Within discrimination groups, findings revealed that subjects who were consistently high discriminators in Kindergarten and Grade One were significantly superior readers and subjects who were consistently low discriminators were the poorer readers in the total Grade One test sample.

In general then children in Grade One who are consistently high discriminators with above-average mental age and adequate auditory memory spans can be expected to become superior readers and those children who are consistently low discriminators and who are younger chronologically and mentally with inadequate auditory memory spans will be poorer readers. At the same time there will also be a group of average pupils in Grade One whose performance in auditory discrimination will change and who may become average or poor readers. As performance of children on auditory tasks during the first three months in Grade One develops, changes or fluctuates, continual informal reassessment of auditory abilities is important.

This study not only supports research studies of Thompson (1963) and Poling (1968) but in addition emphasizes the interrelationship between auditory discrimination and auditory memory span and stresses the importance of both auditory abilities to initial reading achievement.

III. LIMITATIONS AND APPLICABILITY OF THE FINDINGS

In addition to the limitations set forth in Chapter 1, the following limitations may restrict the applicability of the findings of the study:

a) As the research instrument was constructed to investigate the difficulty Grade One children have in the auditory discrimination of stop and nasal sounds, the S-N Auditory Discrimination Test was not intended to be a diagnostic instrument.

b) As the supposedly least difficult test items were deleted from the revised form of the tests and as the results of the

investigation are not definitive, the order of difficulty of sound contrasts for pupils in similar populations may not be exactly the same as reported in this study.

c) While information concerning language environments was obtained from cumulative record cards and verified as far as possible by the investigator, it is possible that more subjects than accounted for in the study were from Non-English language environments. Findings, therfore, pertaining to the relationship between auditory discrimination and language environment in the home are limited to the 32 subjects in this study known to be exposed to two languages.

IV. IMPLICATIONS OF THE STUDY

From results of this study, it is evident that children entering Grade One differ in auditory abilities of acuity, discrimination and memory span and that ability to discriminate sequences of sounds within words and to recall sequences of speech sounds affects initial reading achievement. It would also appear that underlying the development of auditory acuity, auditory discrimination and auditory memory span are common factors of attention, concentration, motivation and interest. Moreover, besides differing in auditory abilities upon entrance to school, children improve and develop these abilities during their first months in Grade One. This suggests the effect of maturation, experience and learning, as well as teaching, on auditory perceptual development, and therfore, the need for frequent assessment of auditory abilities and diagnostic teaching of young children, particularly children who are seemingly slow in developing or children who are fluctuating in their school performance.

For Reading Theory

In learning to read, children rely on a knowledge of speech as they attempt to arrange printed letters in a pattern corresponding to speech sounds. In the beginning reading process, when children attempt to decode words, they must learn that sounds occur in sequence and not only must they attend to initial and final sounds but they must also attend to medial sounds. Furthermore, in the sequencing of sounds, children must learn how one sound influences another sound and thus, influences the sound of the total word. As a result, children eventually learn the importance of duration, stress and intonation in relation to the decoding process in beginning reading. In the initial stages of learning to read, then, a child is dependent upon an adequate auditory identification system.

Basic to the auditory perceptual system, to the process of hearing speech sounds and, therefore, to the process of reading are acoustic-physiological, neuro-physiological, psycho-physiological and linguistic functions. In relation to these functions, results of this study showed that while 93 per cent of the children in Grade One have an accepted standard of satisfactory acuity, 40 per cent of these same children were having difficulty in discriminating stop and nasal sound contrasts in a specific phonemic environment. Therefore, even though the acoustical-physiological function may be considered to be the first and necessary condition for auditory linguistic perception, if the auditory integration and linguistic functions fail, the reception mechanism, however adequate, cannot secure satisfactory auditory perception.

Sensory input is only the beginning of perception. That is, auditory stimuli are not passively absorbed and transmitted by the

perceptual system but are analyzed and transformed. Attention may be conceived of as the mediating process which supports auditory sensory input of speech sounds. This in turn implies a certain amount of learning and experience as well as some previous knowledge in knowing what to attend to. While serving to reduce the influence of competing stimuli, awareness of and attention to auditory stimuli of speech sounds magnifies its influence. Attention plays a crucial role in learning and no actual "hearing" can take place without there first being focus on and attention to the speech signal. It is these processes of attention and concentration influenced by interest which appear to differentiate auditory abilities in young children and facilitate performance on auditory tasks. Motivation which affects interest as well as attention and concentration should be considered as "prime" factors in relation to development of auditory acuity, auditory discrimination and auditory memory span and hence beginning reading.

The fact that young children vary in auditory acuity indicates not only the need for assessing young children's acuity early in life to provide compensatory measures for children with low acuity, but also implies that, to a greater or lesser extent, young children, prior to coming to school, have developed an attentiveness to and an awareness of speech sounds. While keen acuity is needed when children begin to acquire language and become aware of the sound patterns of the English language, keen auditory discrimination ability and adequate auditory memory span is essential as children begin to learn to read.

For Teaching Programs

As results of this investigation indicate that auditory

discrimination ability of children is developmental, one of the implications of the findings of this study is that auditory discrimination programs initiated early in the first year of school should take into consideration the assessment of the child and provide systematic sequential instruction. These implications reveal the need for short informal instruments of assessment and the need to construct sequential programs based on research.

While it is true that perception is fundamental to comprehension in reading and children in learning to read may be taught at too advanced a conceptual level, it is also possible that children beginning school may be taught at a perceptual level which is beyond them. As indicated from this study there are Grade One children who have superior auditory discrimination ability, average auditory discrimination ability and below average auditory discrimination ability. It may be more accurate to state that children in Grade One are at different levels or stages of auditory discrimination. According to performance on the S-N Auditory Discrimination Test, there are children in Grade One who need to acquire and develop fundamental auditory discrimination abilities, children who can discriminate sounds in open syllables who need to develop ability to attend to final sounds in closed syllables, and other children, who as early as the third month in Grade One, having acquired ability to attend to initial and final consonant sounds in closed syllables, are becoming aware of the medial vowel sound within the same consonantal environment. Furthermore, results of the study reveal that children can discriminate stop and nasal sounds in some environments and not in other vowel contexts.

One of the implications arising from this study then is to

examine existing auditory discrimination programs included in basal reading programs. The majority of the programs outlined introduce formal instruction of consonant sounds prior to the teaching of vowel sounds. As indicated by this study, the teaching of consonants in relation to vowel sounds may be more profitable for some children. Besides examining auditory discrimination programs in the basal readers, results of the study reveal the importance of auditory memory span to beginning reading. Basal readers should also be examined to determine if there is any consideration given to the developing of auditory memory spans in Kindergarten or Grade One children.

For Methods

As some Grade One children have not acquired an ability to attend to sounds nor an awareness of sounds, it is possible that these children need basic instruction in auditory discrimination ability. As the basic primitive syllable is open, perhaps some of the important factors of auditory perceptions of speech sounds could be learned and taught through the alphabet. While it is true that many children today are able to sing or say the alphabet, these same children may not be aware of the fact that these sounds are individual speech sounds in the English language. Through motivation by the teacher, children could become interested in learning to use these speech sounds as they begin to realize that the alphabet, these sounds, are important in learning to read. As a result, children would become aware of individual speech sounds, that there are many speech sounds, that each sound is different, that there are sequences of sounds in the alphabet and these sequences of sounds when saying or singing the alphabet have an

order. Furthermore the alphabet would expose children to a vowel sound and to a consonant-vowel unit. As children become aware of consonant and vowel sounds in the alphabet, attention can be drawn to the fact that all consonants are not followed by the same vowel sounds. Discrimination between consonant sounds could then be taught in relation to the vowel sound bearing in mind research from this study that the discrimination of the consonant is dependent upon its phonemic environment. In addition, consideration should also be given to the conclusion that development of auditory discrimination, as in other aspects of language acquisition, is orderly, but orderliness does not imply mastery in sequencing.

In the development of auditory discrimination, competency is dependent upon ability to attend to sounds, an awareness of sounds and knowledge of the sound patterns of the English language. Appropriate learning experiences, therefore, should be provided in classrooms to enable children to acquire an interest in verbal language for sustained periods of time. Teachers, therefore, should provide quiet periods during the day when children can participate actively in listening and responding to interesting stories, dramatizations and conversation, for it is important that children should be able to understand and respond to meaningful sentences and words as they are pronounced before they are required to make fine discrimination between sounds or to isolate a sound from a total sound pattern.

To discriminate sequences of sounds implies a mutual dependency between auditory discrimination and auditory memory span in the early stages of learning to read. As both auditory discrimination ability and auditory memory span are fundamental to beginning reading,

provisions should be made for children coming to school to develop not only adequate auditory discrimination ability but also adequate auditory memory spans. While many teachers are aware of teaching children to discriminate between speech sounds, few seem to be aware that children who do not have a memory span of at least two will have difficulty in discriminating between two words and children with spans of less than three will probably have difficulty in learning to read. As results of the study seem to indicate that children in learning to read should have an auditory memory span of three for letters forward and syllables and a span of two for letters backward implies that teachers in the lower grades through informal games should begin to develop auditory memory spans of young children. Not only would children be developing ability to retain and recall sequences of sounds accurately, but they would also be developing the necessary powers of concentration and sustained attention.

Teachers of school beginners might take notice of the findings of this study that imply that success in beginning reading is dependent upon ability to discriminate speech sounds and to recall sequences of speech sounds accurately. Furthermore, teachers should realize that children find consonant sounds easy or difficult to discriminate depending upon the vowel that precedes or follows the consonant sound. Because development of auditory discrimination and auditory memory span and hence reading ability is dependent upon factors of interest, motivation, attention and concentration, the need for creative and enthusiastic teachers to initiate programs for young children is emphasized.

V. SUGGESTIONS FOR FURTHER RESEARCH

As a result of this investigation the following suggestions might be valuable in planning further research to obtain additional knowledge of development of auditory perceptual abilities and their relationship to beginning reading.

1. There is need to conduct research on ways in which attentiveness to auditory stimuli can be increased in Kindergarten and Grade One children who tend to ignore the significance of speech sounds.

2. A study should also be conducted to determine if there is a relationship between the speech sounds a child in Kindergarten can discriminate in varied phonemic environments and the sounds he can articulate in these same environments.

3. As a result of findings in the present study, it has been possible to determine a general development in auditory discrimination ability of children from the end of Kindergarten to the middle of Grade One. A further study should attempt to assess more extensively the auditory discrimination ability of subjects in Kindergarten. This perhaps could be done by constructing a series of short sequentially planned tests of auditory discrimination. Results of such a study would provide more information to determine a basic developmental pattern in children's ability to discriminate speech sounds.

4. As results of this study indicate a relationship between auditory discrimination and auditory memory span and suggest a mutual dependency between these two auditory abilities, a further study of Kindergarten and Grade One children should be conducted to determine

what effect training in auditory discrimination ability in relation to auditory memory span would have on initial reading achievement, or what effect training auditory memory span in relation to auditory discrimination ability would have on initial reading achievement.

5. There is need for research to investigate the auditory perceptual development of children from Non-English linguistic environments to determine what effect the learning of the phonology of a language other than English has on initial reading achievement.

VII. CONCLUDING STATEMENT

While findings of the present study indicate that the phonemic environment of stop and nasal sounds facilitates auditory discrimination of these sounds, findings also reveal that the various levels or stages in the development of auditory discrimination ability through which children progress appear to be specific to the phonemic environment. Furthermore, results of the study uphold that ability of children to discriminate and recall sequences of sounds is related to initial reading achievement.

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APPENDIX A

Original Form of Auditory Discrimination Test

S-N AUDITORY DISCRIMINATION TEST

DIRECTIONS:

I would like to hear how well you can listen to words on a tape-recorder. Listen to these words and tell me if they sound the same or different.

my	-	by
tight	-	tight
bike	-	bite

Now listen to these words and tell me if they are the same or different.

SCORING:

Mark the number of correct responses for unlike word-pair items and like word-pair items. Total the number of correct responses.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

S-N AUDITORY DISCRIMINATION TEST (ORIGINAL)

1.	top - cop*	26.	peep - peat
2.	gear - beer	27.	doom - boom*
3.	peat - peak	28.	dab - dad
4.	cap - cap*	29.	pip - pit*
5.	boom - boom	30.	ting - king
6.	pin - ping	31.	bake - bait
7.	tim - kim*	32.	bum - bun
8.	babe - bade*	33.	pan - pang*
9.	but - buck	34.	bib - bid
10.	pat - pack	35.	toot - toot*
11.	big - bid*	36.	toque - tote
12.	poon - poon	37.	bock - bot
13.	tote - tope	38.	cane - pain*
14.	bog - bob	39.	ken - ten*
15.	pain - tain*	40.	book - book*
16.	ted - teg*	41.	nape - nape
17.	doom - doom*	42.	get - bet
18.	nib - nib*	43.	peep - peak
19.	beck - deck*	44.	meet - meek
20.	made - made*	45.	nap - map
21.	nut - mutt	46.	sake - shake*
22.	sheep - sheath	47.	tod - cod*
23.	dean - gean	48.	cot - tot*
24.	tog - cog*	49.	poon - coon*
25.	tune - poon*	50.	peak - teak*

*Omitted from revised form

51.	dune	-	boon*
52.	gag	-	gab*
53.	pick	-	pip
54.	main	-	maim
55.	deign	-	bane
56.	buck	-	duck*
57.	pam	-	pang*
58.	big	-	bib*
59.	coop	-	coop
60.	toque	-	tope
61	bomb	-	bon
62.	take	-	tape
63.	keg	-	teg
64.	good	-	good
65.	winning	-	winging
66.	meat	-	neat
67.	met	-	met
68.	mum	-	numb
69.	mab	-	nab
70.	bid	-	did*
71.	cop	-	cock
72.	coop	-	poop
73.	peat	-	teat
74.	goon	-	boon*
75.	gad	-	gag
76.	pick	-	pit*
77.	mem	-	men
78.	bait	-	date*
79.	dug	-	bug
80.	pam	-	pan
81.	bin	-	bing*
82.	took	-	took
83.	cope	-	coke
84.	bon	-	bong
85.	tame	-	tain
86.	sinner	-	singer
87.	pug	-	pub
88.	dote	-	dote
89.	beck	-	deck*
90.	neb	-	neb*
91.	numb	-	nun
92.	knack	-	mack*
93.	wing	-	wing*
94.	cock	-	cot*
95.	tomb	-	tune
96.	keep	-	peep
97.	doom	-	dune
98.	gab	-	bad*
99.	pin	-	tin*
100.	name	-	maim*

101.	bait	-	gait*	126.	bale	-	vale
102.	bun	-	done*	127.	poke	-	poke
103.	pad	-	tad*	128.	pup	-	putt*
104.	bing	-	ding	129.	bog	-	dog*
105.	could	-	could	130.	cape	-	cake
106.	cope	-	coke	131.	ked	-	ted
107.	brimming-bringing			132.	bog	-	bog
108.	mead	-	need	133.	gab	-	gab
109.	putt	-	puck	134.	back	-	bat
110.	came	-	cane	135.	nag	-	nag
111.	goad	-	goad*	136.	gong	-	dong*
112.	ged	-	dead*	137.	nap	-	gnat
113.	mad	-	mad	138.	bug	-	bud
114.	gone	-	don	139.	cob	-	cod*
115.	nap	-	knack	140.	toot	-	coot
116.	big	-	dig	141.	teen	-	team*
117.	cot	-	cop*	142.	dune	-	goon
118.	coon	-	tune*	143.	dag	-	gag
119.	keep	-	peep*	144.	tip	-	pip*
120.	goom	-	goon*	145.	met	-	net
121.	gap	-	gat	146.	deign	-	dame
122.	bane	-	gain*	147.	shape	-	shake
123.	mud	-	mug	148.	pup	-	puck*
124.	but	-	gut	149.	bib	-	dib
125.	pang-	-	tang	150.	coke	-	coat

151. bot - dot*
152. take - cake
153. tack - pack*
154. dog - dog*
155. mood - nude
156. ban - bang
157. bead - bead
158. got - dot*
159. knack - gnat
160. big - gib*
161. cog - cob
162. cook - took
163. teen- - keen
164. good - dude
165. dab - gab
166. ting - ping*
167. cap - cat*
168. tuck - puck
169. dug - dub
170. tan - pan
171. bin - din
172. coke - coke
173. cone - comb
174. bong - dong
175. tape - cape*
176. tat - tack
177. gob - gob
178. dean - dean
179. bam - ban
180. dag - dag
181. moon - noon
182. nag - nab*
183. fret - threat
184. cod - cog
185. teg - teg
186. poke - pope*
187. beak - beep
188. boat - dote
189. bad - bag*
190. pun - ton*
191. tin - ting*
192. gape - gate*
193. dud - dub
194. pam - tam
195. big - gig*
196. pot - pot
197. toad - code*
198. bock - dock*
199. tame - came
200. cab - cad

201.	nog	-	nod	226.	ban	-	dan
202.	puck	-	puck	227.	cup	-	cup
203.	bad	-	dad*	228.	bid	-	bid
204.	gean	-	gean	229.	mode	-	node
205.	mote	-	mope*	230.	wedge	-	wedge
206.	peak	-	peak	231.	top	-	tot
207.	gib	-	gid	232.	poke	-	toque
208.	tod	-	tog	233.	beep	-	beat
209.	pome	-	pone	234.	goat	-	boat
210.	beak	-	beat	235.	mid	-	mig*
211.	bode	-	goad	236.	pit	-	kit*
212.	dad	-	gad*	237.	mab	-	mad
213.	ping	-	king*	238.	game	-	dame
214.	neck	-	net	239.	done	-	dung*
215.	deign	-	gain	240.	pan	-	can
216.	dug	-	dug*	241.	tug	-	tub
217.	pat	-	tat*	242.	cog	-	cog
218.	bid	-	gid*	243.	pub	-	tub
219.	tog	-	tog	244.	bon	-	don
220.	tome	-	tome	245.	pep	-	pet
221.	rub	-	rug*	246.	cat	-	cap
222.	tug	-	pug	247.	bug	-	bug
223.	tain	-	cane	248.	calm	-	palm
224.	tome	-	comb*	249.	mope	-	nope*
225.	nob	-	nod	250.	tuck	-	tuck

251.	mote	-	note*	276.	teak	-	teak
252.	bag	-	bag*	277.	dig	-	dig*
253.	gib	-	gig	278.	balm	-	balm
254.	pod	-	cod*	279.	guile	-	dial
255.	pome	-	tome*	280.	cop	-	pop*
256	beam	-	bean	281.	bead	-	deed*
257.	dote	-	dope*	282.	goat	-	dote*
258.	mitt	-	knit	283.	keg	-	keg*
259.	pick	-	pick*	284.	pone	-	tone*
260.	mat	-	map	285.	knit	-	nick*
261.	gate	-	date*	286.	kin	-	pin*
262.	rung	-	rum*	287.	sung	-	sun
263.	pup	-	cup*	288.	putt	-	cut*
264.	din	-	ding*	289.	dumb	-	done*
265.	moot	-	moot	290.	cat	-	pat*
266.	tope	-	cope*	291.	dick	-	dip*
267.	gob	-	bob*	292.	noon	-	noon
268.	pep	-	peck*	293.	tote	-	coat
269.	pad	-	cad*	294.	gong	-	bong*
270.	moan	-	known	295.	pet	-	peck
271.	dug	-	dug	296.	cam	-	can
272.	bam	-	dam*	297.	gut	-	gut
273.	nope	-	note*	298.	mob	-	mod
274.	gib	-	gib	299.	bad	-	gad*
275.	bag	-	dag	300.	mop	-	mock*

301. bade - bade
302. keep - keep*
303. dig - gig*
304. cock - pock*
305. cope - pope
306. beep - deep*
307. nip - knit
308. cope - coke
309. cub - pub*
310. tip - tick
311. beg - bed
312. gum - gun*
313. kam - pam*
314. dig - did
315. mode - mode
316. tone - cone*
317. got - bot*
318. peck - tech*
319. tan - can
320. mug - mug
321. knock - mock
322. gag - bag*
323. deign - deign
324. knob - mob*
325. pig - pig
326. sick - thick*
327. pot - cot*
328. coke - poke*
329. bean - dean*
330. ton - tongue
331. kick - kit
332. man - maam*
333. bet - beck
334. gum - dumb*
335. tab - tag
336. dim - din*
337. node - node
338. pop - pock
339. gone - bon
340. ten - pen*
341. tab - cab*
342. nut - nut
343. gain - gain*
344. gang - bang*
345. tip - tip
346. mog - mod*
347. kit - kit*
348. did - gid
349. pod - cod*
350. pack - pack*

351.	cone	-	pone*
352.	beam	-	deem*
353.	cut	-	cup
354.	nip	-	nick*
355.	kin	-	king
356.	mack	-	mat
357.	cog	-	cob
358.	bet	-	debt
359.	don	-	gone
360.	tap	-	tack
361.	dib	-	did*
362.	mog	-	mog
363.	pot	-	pop
364.	dock	-	dot
365.	teg	-	peg*
366.	cad	-	tad
367.	mean	-	mean*
368.	beg	-	beg
369.	dam	-	dan
370.	mog	-	mob
371.	paid	-	paid
372.	peck	-	peck*
373.	cat	-	pat*
374.	tod	-	pod*
375.	pome	-	comb*
376.	bean	-	gean*
377.	cud	-	cub
378.	nib	-	nig*
379.	tin	-	kin
380.	mack	-	map*
381.	bed	-	dead
382.	mud	-	mug
383.	tan	-	tam
384.	dib	-	dig*
385.	nob	-	nob
386.	pot	-	pock
387.	don	-	dong
388.	pen	-	ken
389.	tap	-	cap
390.	need	-	need*
391.	mod	-	nod
392.	dag	-	dab*
393.	mog	-	nog
394.	deb	-	deb
395.	cape	-	cape*
396.	pop	-	top
397.	dib	-	gib*
398.	tap	-	tap*
399.	tome	-	tone
400.	deam	-	dean*

401. tub - cub*

402. make - mate

403. tick - kick

404. gnat - mat*

405. ben - den

406. mutt - muck

407. tap - tat

408. gid - gig

409. boob - boob

410. tong - pong

411. god - gob

412. peg - keg*

413. tam - cam

414. nog - nob

415. mim - mim

416. dad - dag*

417. geck - geck

418. take - take

419. not - knock

420. tot - pot*

421. game - gain

422. palm - palm

423. gawk - dock*

424. daub - gob

425. talk - cock*

APPENDIX B

I. Revised Form of S-N Auditory Discrimination Test

II. Difficulty Indexes of Word-Pair Items According to Sound Contrasts

S-N AUDITORY DISCRIMINATION TEST

DIRECTIONS:

I would like to hear how well you can listen to words on a tape-recorder. Listen to these words and tell me if they sound the same or different.

my	-	by
tight	-	tight
bike	-	bite

Now listen to these words and tell me if they are the same or different.

SCORING:

Mark the number of correct responses for unlike word-pair items and like word-pair items. Total the number of correct responses.

S-N AUDITORY DISCRIMINATION TEST
(Revised)

1.	mod	-	nod*	26.	cup	-	cup
2.	gear	-	bear	27.	nob	-	nob
3.	peet	-	peak	28.	dab	-	dad
4.	dug	-	dug	29.	dag	-	gag
5.	boom	-	boom	30.	ting	-	king
6.	pin	-	ping	31.	bake	-	bait
7.	tame	-	came	32.	bum	-	bun
8.	bade	-	bade	33.	tam	-	cam
9.	but	-	buck	34.	bib	-	bid
10.	pat	-	pack	35.	take	-	take
11.	daub	-	gob	36.	toque	-	tote
12.	poon	-	poon	37.	bock	-	bot
13.	tote	-	tope	38.	tab	-	tag
14.	bog	-	bob	39.	tin	-	kin
15.	dune	-	goon	40.	pan	-	can
16.	pet	-	peck	41.	nape	-	nape
17.	palm	-	palm	42.	bet	-	get
18.	min	-	mim	43.	peep	-	peak
19.	cog	-	cob	44.	meet	-	meek
20.	mack	-	mat	45.	nap	-	map
21.	nut	-	mutt	46.	gib	-	gig
22.	sheep	-	sheath	47.	nog	-	nob
23.	dean	-	gean	48.	bet	-	debt
24.	not	-	knock	49.	mutt	-	muck
25.	bag	-	dag	50.	beg	-	beg

* See Table following for sound contrasts examined.

[illegible]

51. mog - nog
52. coop - coop
53. pick - pip
54. main - maim
55. deign - bane
56. cut - cup
57. pot - pop
58. gean - gean
59. mob - mod
60. toque - tope
61. bomb - bon
62. take - tape
63. keg - teg
64. mock - knock
65. winning - winging
66. meat - neat
67. met - met
68. calm - calm
69. mab - nab
70. mitt - knit
71. cop - cock
72. coop - poop
73. peat - teat
74. mog - mob
75. gad - gag
76. good - good
77. mug - mug
78. nap - gnat
79. cub - cub
80. dug - bug
81. bid - bid
82. pam - pan
83. took - took
84. cope - coke
85. tame - tain
86. sinner - singer
87. pug - pub
88. dote - dote
89. bet - beck
90. god - gob
91 numb - nun
92. bon - bong
93. tong - pong
94. pop - top
95. tomb - tune
96. keep - peep
97. gib - gib
98. doom - dune
99. tap - tat
100. pang - tang

101. mood - nude
102. moot - moot
103. game - gain
104. tap - cap
105. bing - ding
106. could - could
197. mode - mode
108. brimming - bringing
109. mead - need
110. putt - puck
111. came - cane
112. deb - deb
113. ben - den
114. mad - mad
115. kin - king
116. nap - knack
117. big - dig
118. tog - tog
119. tan - tam
120. make - mate
121. gone - bon
122. pit - pit
123. gap - gat
124. mud - mug
125. but - gut
126. tap - tack
127. noon - noon
128. bale - vale
129. poke - poke
130. cad - tad
131. don - dong
132. cape - cake
133. ked - ted
134. bog - bog
135. gab - gab
136. back - bat
137. beak - beat
138. nag - nag
139. deem - dean
140. mem - men
141. bug - bud
142. dam - dan
143. tip - tip
144. toot - coot
145. pot - pock
146. neck - net
147. mum - numb
148. met - net
149. deign - dame
150. pig - pig

151. tan - can
152. take - cake
153. paid - paid
154. deign - deign
155. tip - tick
156. ban - bang
157. bead - bead
158. kick - kit
159. knack - gnat
160. moan - known
161. cope - pope
162. cook - took
163. teen - keen
164. palm - calm
165. dab - gab
166. did - gid
167. bed - dead
168. tuck - puck
169. dug - dub
170. tan - pan
171. bin - din
172. coke - coke
173. cone - comb
174. bong - dong
175. dig - did
176. tat - tack
177. gob - gob
178. dean - dean
179. bam - ban
180. dag - dag
181. moon - noon
182. nut - nut
183. fret - threat
184. cod - cog
185. teg - teg
186. pop - pock
187. beak - beep
188. boat - dote
189. beg - bed
190. ton - tongue
191. nip - knit
192. cope - cope
193. dud - dub
194. pam - tam
195. mat - map
196. pot - pot
197. balm - balm
198. dude - good
199. pen - ken
200. cab - cad

201.	nog	-	nod
202.	puck	-	puck
203.	gone	-	don
204.	gid	-	gig
205.	tote	-	coat
206.	peak	-	peak
207.	gib	-	gid
208.	tod	-	tog
209.	pome	-	pone
210.	bib	-	dib
211.	bode	-	goad
212.	teak	-	teak
213.	guile	-	dial
214.	neck	-	neck
215.	deign	-	gain
216.	gut	-	gut
217.	geck	-	geck
218.	shape	-	shake
219.	mod	-	mod
220.	tome	-	tome
221.	cam	-	can
222.	tug	-	pug
223.	tain	-	cane
224.	node	-	node
225.	nob	-	nod
226.	ban	-	dan
227.	peep	-	peat
228.	beam	-	bean
229.	mode	-	mode
230.	wedge	-	wedge
231.	top	-	tot
232.	poke	-	toque
233.	beep	-	beat
234.	goat	-	boat
235.	boob	-	boob
236.	sung	-	sun
237.	mab	-	mad
238.	game	-	dame
239.	tick	-	kick
240.	tome	-	tone
241.	tug	-	tub
242.	cog	-	cog
243.	pub	-	tub
244.	bon	-	don
245.	pep	-	pet
246.	cat	-	cap
247.	bug	-	bug
248.	coke	-	coat
249.	dock	-	dot
250.	tuck	-	tuck

TABLE B.1

DIFFICULTY INDEXES OF WEPMAN AND FAST-COSENS WORD-PAIR ITEMS RETAINED IN S-N AUDITORY DISCRIMINATION TEST

Word-Pair Item	Kindergarten Difficulty Index	Grade One Difficulty Index
fret-threat	.330	.270
shape-shake	.380	.610
sung-sun	.590	.770
bale-vale	.630	.910
sheep-sheath	.670	.780
brimming-bringing	.670	.860
guile-dial	.700	.880
sinner-singer	.730	.870
wedge-wedge	.760	.960
winning-winging	.790	.900
gear-beer	.870	.850

TABLE B.2

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL SOUNDS PRECEDING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voice	Difficulty Index		Nasal	Difficulty Index	
		K	Gr.1		K	Gr.1		K.	Gr.1
Bilabial	peep-peat	.440	.770	beam-bean	.280	.530	min-mim	.440	.570
High	peep-peak	.600	.780	beak-beep	.470	.710	meet-meek	.650	.760
Front	peat-peak	.680	.760	beak-beat	.560	.790			
Vowel	peak-peak	.750	.920	beep-beat	.570	.780			
	pick-pip	.640	.840	bead-bead	.780	.830			
	pit-pit	.710	.750	bib-bid	.530	.660			
	pig-pig	.770	.860	bid-bid	.670	.900			
	pin-ping	.790	.830						
Mid	paid-paid	.820	.960	bake-bait	.590	.730	main-maim	.310	.350
Front	pep-pet	.480	.700	bade-bade	.750	.860	make-mate	.550	.840
Vowel	pet-peck	.660	.740	bet-beck	.540	.730	mem-men	.430	.570
				beg-bed	.660	.890	met-met	.870	.840
				beg-beg	.780	.870			
Low	pat-pack	.430	.420	bam-ban	.350	.650	mab-mad	.490	
Front	pam-pan	.470	.570	back-bat	.610	.780	mat-map	.610	.730
Vowell				ban-bang	.700	.880	mack-mat	.650	.870
							mad-mad	.870	.880

TABLE B.3

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL ALVEOLAR SOUNDS PRECEDING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Alveolar	teak-teak	.840	.890	deem-dean	.400	.570	nip-knit	.630	.830
High	tip-tick	.710	.860	dean-dean	.790	.920			
Front	tip-tip	.720	.860	dig-did	.580	.850			
Vowel									
Mid	tame-tain	.390	.570	deign-dame	.340	.440	nape-nape	.760	.840
Front	take-tape	.550	.690	deign-deign	.830	.890	neck-net	.760	.870
Vowel	take-take	.720	.830	deb-deb	.790	.850	neck-neck	.770	.840
	teg-teg	.770	.890						
Low	tan-tam	.410	.580	dam-dan	.510	.630	knack-gnat	.530	.770
Front	tat-tack	.460	.710	dab-dad	.680	.800	nap-knack	.620	.820
Vowel	tap-tat	.530	.730	dag-dag	.700	.760	nap-gnat	.660	.830
	tap-tack	.540	.720				mag-nag	.780	.810
	tab-tag	.770	.900						

TABLE B.4

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL VELAR SOUNDS PRECEDING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Velar	kick-kit	.610	.810	gean-gean	.770	.870			
High	kin-king	.780	.910	gid-gig	.340	.590			
Front				gib-gid	.340	.610			
Vowel				gib-gib	.710	.810			
				gib-gig	.770	.800			
Mid	came-cane	.450	.590	game-gain	.400	.600			
Front	cape-cake	.570	.760	geck-geck	.750	.730			
Vowel									
Low	cam-can	.290	.550	gap-gat	.600	.750			
Front	cab-cad	.460	.720	gad-gag	.600	.780			
Vowel	cat-cap	.500	.690	gab-gab	.770	.820			

TABLE B.5

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL-ALVEOLAR CONTRASTS PRECEDING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial	peat-teat	.790	.870	big-dig	.700	.920	mead-need	.270	.530
Alveolar				bin-din	.710	.870	meat-neat	.300	.540
High				bib-dib	.760	.890	mitt-knit	.630	.790
Front				bing-ding	.770	.870			
Vowel									
Mid				deign-bane	.760	.850	met-net	.640	.800
Front				ben-den	.690	.800			
Vowel				bed-dead	.780	.860			
				bet-debt	.790	.870			
Low	pam-tam	.710	.830	ban-dan	.590	.880	mab-nab	.630	.830
Front	pang-tang	.730	.850	bag-dag	.770	.900	nap-map	.790	.780
Vowel	tan-pan	.810	.840						

TABLE B.6

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL ALVEOLAR-VELAR SOUND CONTRASTS PRECEDING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Alveolar	teen-keen	.710	.830	dean-gean	.730	.850			
Velar	tin-kin	.720	.880	did-gid	.600	.840			
High	tick-kick	.720	.890						
Front	ting-king	.750	.860						
Vowel									
Mid	tain-cane	.500	.790	game-dame	.640	.810			
Front	tame-came	.820	.870	deign-gain	.720	.900			
Vowel	take-cake	.700	.860						
	keg-teg	.560	.700						
	ked-ted	.740	.890						
Low	tap-cap	.660	.830	dab-gab	.720	.850			
Front	tan-can	.660	.880	dag-gag	.780	.920			
Vowel	tam-can	.670	.780						
	cad-tad	.690	.810						

[illegible]

TABLE B.7

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL-VELAR SOUND CONTRASTS PRECEDING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial Velar High Front Vowel	keep-peep	.710	.860						
Mid Front Vowel	pen-ken	.790	.890	bet-get	.740	.880			
Low Front Vowel	pan-can	.790	.800						

[illegible]

TABLE B.8

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL, ALVEOLAR, VELAR SOUNDS PRECEDING CENTER VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial	putt-puck	.630	.870	bug-bud	.580	.850	mud-mug	.490	.770
	pug-pub	.650	.790	but-buck	.660	.800	mutt-muck	.770	.820
	puck-puck	.830	.950	bum-bun	.750	.890	mug-mug	.800	.850
				bug-bug	.770	.940			
Alveolar	tug-tub	.370	.570	dug-dub	.480	.670	numb-num	.760	.810
	ton-tongue	.470	.560	dud-dub	.480	.790	nut-nut	.890	.940
	tuck-tuck	.760	.910	dug-dug	.790	.920			
Velar	cut-cup	.550	.840	gut-gut	.730	.940			
	cud-cub	.600	.800						
	cup-cup	.730	.870						

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[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE B.9

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL-ALVEOLAR AND BILABIAL-VELAR SOUND CONTRASTS PRECEDING CENTER VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr. 1		K	Gr.1		K	Gr.1
Bilabial	tug-pug	.740	.920	dug-bug	.810	.850	mum-numb	.760	.900
Alveolar	pub-tub	.780	.880				nut-mutt	.760	.920
	tuck-puck	.820	.910						
Bilabial				but-gut	.810	.910			
Velar									

TABLE B. 10

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL SOUNDS PRECEDING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial	poon-poon	.820	.820	boom-boom	.670	.720	moot-moot	.820	.870
High				boob-boob	.680	.740			
Back									
Vowels									
Mid	pome-pone	.330	.440				mode-mode	.830	.940
Back Vowels	poke-poke	.780	.910						
Low	pop-pock	.510	.800	bog-bob	.490	.600	mog-mob	.610	.730
Back	pot-pop	.690	.790	bon-bong	.560	.610	mob-mod	.690	.840
Vowels	pot-pock	.700	.840	bomb-bon	.590	.740	mod-mod	.800	.890
	pot-pot	.850	.870	bock-bot	.670	.800			
	palm-palm	.740	.870	balm-balm	.720	.890			
				bog-bog	.730	.770			

TABLE B.11

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL ALVEOLAR SOUNDS PRECEDING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Alveolar	tomb-tune	.490	.470	doom-dune	.360	.550	noon-noon	.830	.880
High	took-took	.800	.910						
Back									
Vowels									
Mid	tome-tone	.320	.430	dote-dote	.750	.810	node-node	.760	.830
Back	toque-tope	.430	.640						
Vowels	tote-tope	.590	.700						
	toque-tote	.640	.710						
	tome-tome	.840	.880						
Low	tod-tog	.410	.680	dock-dot	.570	.770	nog-nod	.360	.650
Back	top-tot	.520	.820	don-dong	.580	.780	nob-nod	.440	.750
Vowel	tog-tog	.740	.810				not-knock	.640	.880
							nog-nob	.670	.780
							nob-nob	.800	.870

TABLE B.12

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL VELAR SOUNDS PRECEDING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Velar	coop-coop	.820	.890	good-good	.860	.970			
High	could-could	.810	.860						
Back									
Vowels									
Mid	cone-comb	.550	.580						
Back	coke-cope	.590	.810						
Vowels	coke-coat	.710	.810						
	coke-coke	.780	.820						
	cope-cope	.660	.850						
Low	cod-cog	.410	.600	god-gob	.560	.730			
Back	cog-cob	.550	.640	gob-gob	.710	.770			
Vowels	cop-cock	.620	.720						
	cog-cog	.630	.760						
	calm-calm	.800	.870						

TABLE B.13

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL-ALVEOLAR SOUND CONTRASTS PRECEDING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial Alveolar High Back Vowel							moon-noon	.760	.850
							mood-nude	.830	.880
Mid Back Vowel	poke-toque	.820	.900	boat-dote	.830	.910	mode-node	.600	.890
							moan-known	.720	.880
Low Back Vowel	pop-top	.790	.860	bon-don	.810	.940	mock-knock	.770	.840
	tong-pong	.830	.900	bong-dong	.820	.880	mod-nod	.800	.860
							mog-nog	.820	.900

TABLE B.14

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL ALVEOLAR-VELAR SOUND CONTRASTS PRECEDING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Velar	toot-coot	.830	.900	dune-goon	.810	.870			
Alveolar	cook-took	.810	.870	dude-good	.770	.900			
High									
Back Vowel									
Mid	tote-coat	.850	.890						
Back									
Vowel									
Low				gone-don	.810	.910			
Back				daub-gob	.830	.860			
Vowel									

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[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE B.15

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING INITIAL BILABIAL-VELAR SOUND CONTRASTS PRECEDING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial-Velar High Back Vowel	coop-poop	.760	.870						
Mid Back Vowel	cope-pope	.760	.890	bode-goad	.750	.900			
				goat-boat	.840	.900			
Low Back Vowel	palm-calm	.780	.890	gone-bon	.780	.850			

TABLE B.16

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL ALVEOLAR SOUNDS FOLLOWING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Alveolar	meet-neat	.300	.540	need-mead	.270	.550	teen-keen	.710	.830
High	peat-teat	.790	.870	bead-bead	.780	.830	dean-gean	.730	.850
Front	mitt-knit	.630	.790	did-gid	.600	.840	gean-gean	.770	.870
Vowel	pit-pit	.710	.750	bid-bid	.670	.770	dean-dean	.790	.920
							bin-din	.710	.870
							tin-kin	.720	.880
Mid	met-net	.640	.800	bade-bade	.750	.860	tain-cane	.500	.790
Front	bet-get	.740	.880	paid-paid	.820	.960	deign-gain	.720	.900
Vowel	bet-debt	.790	.870	ked-ted	.740	.890	deign-bane	.760	.850
	met-met	.870	.840	bed-dead	.780	.860	deign-deign	.830	.890
							ben-den	.690	.800
							pen-ken	.790	.890
Low				tad-cad	.690	.810	ban-dan	.630	.880
Front				mad-mad	.870	.880	tan-can	.660	.880
Vowel							pan-can	.790	.800
							tan-pan	.810	.840

TABLE B.17

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL SOUNDS FOLLOWING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial	keep-peep	.700	.860	gib-gib	.710	.810			
High	tip-tip	.720	.860	bib-dib	.760	.890			
Front									
Vowel									
Mid	nape-nape	.760	.840	deb-deb	.790	.850	game-dame	.640	.810
Front							tame-came	.820	.870
Vowel									
Low	nap-map	.660	.780	mab-nab	.630	.830	tam-cam	.670	.780
Front	tap-cap	.660	.830	dab-gab	.720	.850	pam-tam	.710	.830
Vowel				gab-gab	.770	.820			

TABLE B.18

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL VELAR SOUNDS FOLLOWING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Velar	peak-peak	.750	.920	big-dig	.760	.920	ting-king	.760	.860
High	teak-teak	.840	.890	pig-pig	.770	.860	bing-ding	.770	.870
Front	tick-tick	.720	.890						
Vowel									
Mid	cake-take	.700	.860	keg-teg	.560	.700			
Front	take-take	.720	.830	teg-teg	.770	.890			
Vowel	geck-geck	.750	.730	beg-beg	.780	.870			
	neck-neck	.770	.840						
Low				dag-dag	.700	.760	pang-tang	.730	.850
Front				bag-dag	.770	.900			
Vowel				nag-nag	.780	.810			
				dag-gag	.780	.920			

TABLE B.19

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL-ALVEOLAR SOUND CONTRASTS FOLLOWING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial	peep-peat	.430	.770	gib-gid	.340	.610	bean-beam	.280	.530
Alveolar	beep-beat	.570	.780	bid-bib	.530	.660	deem-dean	.400	.570
High	nip-knit	.630	.830				min-mim	.440	.570
Mid	pep-pet	.480	.700				main-maim	.310	.350
Front							deign-dame	.340	.440
							tame-tain	.390	.570
Vowel							game-gain	.400	.600
							came-cane	.450	.590
							mem-men	.430	.570
Low	cap-cat	.500	.690	cab-cad	.460	.720	cam-can	.290	.550
Front	tap-tat	.530	.770	mab-mad	.490	.700	bam-ban	.350	.650
Vowel	gap-gat	.600	.750	dab-dad	.680	.800	tan-tam	.410	.580
	mat-map	.610	.730				pam-pan	.470	.570
	nap-gnat	.660	.830				dam-dan	.510	.630

TABLE B.20

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL ALVEOLAR-VELAR SOUND CONTRASTS FOLLOWING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Alveolar	beak-beat	.560	.790	gid-gig	.340	.590	kin-king	.780	.910
Velar	meat-meek	.650	.760	dig-did	.580	.850	pin-ping	.790	.830
High	peat-peak	.680	.760						
Front	kick-kit	.610	.810						
Vowel									
Mid	make-mate	.550	.840	beg-bed	.660	.890			
Front	bake-bait	.590	.730						
Vowel	bet-beck	.540	.730						
	pet-peck	.660	.740						
	neck-net	.760	.870						
Low	pat-pack	.430	.410	gad-gag	.600	.780	ban-bang	.700	.881
Front	tat-tack	.460	.710						
Vowel	knack-gnat	.530	.770						
	back-bat	.610	.780						
	mack-mat	.650	.870						

TABLE B.21

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL-VELAR SOUND CONTRASTS FOLLOWING FRONT VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial	beak-beep	.470	.710	gib-gig	.770	.800			
Velar	peep-peak	.600	.780						
High	pick-pip	.640	.840						
Front	tip-tick	.710	.860						
Vowel									
Mid	take-tape	.550	.690						
Front	cake-cape	.570	.760						
Vowel									
Low	tap-tack	.540	.720	tab-tag	.770	.870			
Front	nap-knack	.620	.820						
Vowel									

TABLE B.22

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL, ALVEOLAR, VELAR SOUNDS FOLLOWING CENTER VOWEL SOUNDS

	Voiceless	Difficulty Index K	Difficulty Index Gr.1	Voiced	Difficulty Index K	Difficulty Index Gr.1	Nasals	Difficulty Index K	Difficulty Index Gr.1
Alveolar	gut-gut	.730	.940						
	nut-mutt	.760	.920						
	but-gut	.810	.910						
	nut-nut	.890	.940						
Velar	tuck-tuck	.760	.910	tug-pug	.740	.920			
	tuck-puck	.820	.910	bug-bug	.770	.940			
	puck-puck	.830	.950	dug-dug	.790	.920			
				mug-mug	.800	.850			
				dug-bug	.810	.850			
Bilabial	cup-cup	.730	.870	pub-tub	.780	.880	mum-numb	.760	.990

TABLE B.23

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL-ALVEOLAR, BILABIAL-VELAR AND ALVEOLAR-VELAR SOUND CONTRASTS FOLLOWING CENTER VOWEL SOUNDS

	Voiceless	Difficulty Index K	Difficulty Index Gr.1	Voiced	Difficulty Index K	Difficulty Index Gr.1	Nasals	Difficulty Index K	Difficulty Index Gr.1
Bilabial	cut-cup	.550	.840	dud-dub	.480	.790	bum-bun	.750	.890
Alveolar				cud-cub	.600	.800	numb-nun	.760	.810
Bilabial				tug-tub	.370	.570			
Velar				dug-dub	.480	.670			
				pug-pub	.650	.790			
Alveolar	putt-puck	.630	.870	mud-mug	.490	.770	ton-tongue	.470	.560
Velar	but-buck	.660	.800	bug-bud	.580	.850			
	mutt-muck	.770	.820						

TABLE B.24

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL SOUNDS FOLLOWING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial	coop-poop	.760	.870	boob-boob	.680	.740	boom-boom	.670	.720
High	coop-coop	.820	.910						
Back									
Vowel									
Mid	cope-cope	.660	.850				tome-tome	.840	.880
Back	cope-pope	.760	.890						
Vowel									
Low	pop-top	.790	.860	gob-gob	.710	.770	balm-balm	.720	.890
Back				nob-nob	.800	.870	palm-palm	.740	.870
Vowel				daub-gob	.830	.860	palm-calm	.780	.890
							calm-calm	.800	.870

TABLE B.25

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL ALVEOLAR SOUNDS FOLLOWING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Alveolar	moot-moot	.820	.870	dude-good	.770	.900	moon-noon	.760	.850
High	toot-coot	.830	.900	could-could	.810	.860	dune-goon	.810	.870
Back				mood-nude	.830	.880	poon-poon	.820	.820
Vowel				good-good	.860	.970	noon-noon	.830	.880
Mid	dote-dote	.750	.810	mode-node	.600	.890	moan-known	.720	.880
Back	goat-boat	.830	.900	node-node	.760	.830			
Vowel	boat-dote	.830	.910	bode-goad	.770	.900			
	tote-coat	.850	.890	mode-mode	.830	.940			
Low	pot-pot	.850	.870	mod-mod	.770	.890	gone-bon	.780	.850
Back				mod-nod	.800	.860	gone-don	.810	.910
Vowel							bon-don	.810	.940

TABLE B.26

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL VELAR SOUNDS FOLLOWING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Velar	took-cook	.810	.870						
High	took-took	.850	.910						
Back									
Vowel									
Mid	coke-coke	.780	.820						
Back	poke-poke	.780	.910						
Vowel	poke-toque	.820	.900						
Low	mock-knock	.770	.840	cog-cog	.630	.760	bong-dong	.820	.880
Back				bog-bog	.730	.770	tong-pong	.830	.900
Vowel				tog-tog	.740	.810			
				mog-nog	.820	.900			

TABLE B.27

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL-ALVEOLAR SOUND CONTRASTS FOLLOWING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial							doom-dune	.360	.550
Alveolar							tomb-tune	.490	.470
High Back									
Vowel									
Mid	tote-tope	.590	.700				tome-tone	.320	.430
Back							pome-pone	.330	.450
Vowel							cone-comb	.550	.580
Low	top-tot	.520	.820	nob-nod	.440	.750	bomb-bon	.590	.740
Back	pot-pop	.690	.790	god-gob	.560	.730			
Vowel				mob-mod	.690	.840			

TABLE B.28

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL ALVEOLAR-VELAR SOUND CONTRASTS FOLLOWING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index K	Difficulty Index Gr.1	Voiced	Difficulty Index K	Difficulty Index Gr.1	Nasals	Difficulty Index K	Difficulty Index Gr.1
Alveolar Velar High Back Vowel									
Mid	toque-tote	.640	.710						
Back	coke-coat	.710	.810						
Vowel									
Low	dock-dot	.570	.770	nog-nod	.360	.650	bon-bong	.560	.610
Back	not-knock	.640	.880	cod-cog	.410	.600	don-dong	.580	.780
Vowel	bock-bot	.670	.800	tod-tog	.410	.680			
	pot-pock	.700	.840						

TABLE B.29

DIFFICULTY INDEXES OF WORD-PAIR ITEMS CONTAINING FINAL BILABIAL-VELAR SOUND CONTRASTS FOLLOWING BACK VOWEL SOUNDS

	Voiceless	Difficulty Index		Voiced	Difficulty Index		Nasals	Difficulty Index	
		K	Gr.1		K	Gr.1		K	Gr.1
Bilabial Velar High Back Vowel									
Mid Back Vowel	toque-tope	.430	.640						
	cope-coke	.530	.810						
Low Back Vowel	pop-pock	.510	.800	bog-bob	.490	.600			
	cop-cock	.620	.720	cog-cob	.550	.640			
				mog-mob	.610	.730			
				nog-nob	.670	.780			

APPENDIX C

I. Auditory Memory Span Tests

LETTER SPAN TEST

These tests are administered separately. The highest number of letters correctly reproduced on each are added to give a total score.

Digits Forward

Directions: Say, "I am going to say some letters. Listen carefully, and when I am through say them right after me. For example, if I say 'D B', what would you say?"

Trial I	Trial II
1. T N G	1. G P B
2. T D P M	2. G P K N
3. N D B T C	3. K B P N G
4. T N C P M D	4. M C G D N T
5. K P M D B T N	5. C N K B P G T
6. P G D K C M G T	6. B C M G T P K D
7. K T N M P B D G C	7. D B G C P M N T K

Digits Backward

Directions: Say, "Now I am going to say some more letters, but this time when I stop I want you to say them backwards. For example, if I say 'B M', what would you say?"

Trial I	Trial II
1. B K	1. G T
2. K M D	2. B K C
3. M B C G	3. N D C T
4. D P T K M	4. C M N K B
5. P G K B C N	5. T G M P C D
6. N K C B T D B	6. D K M C B N P
7. G C P G T B K N	7. T P M C K D N B

TEST FOR AUDITORY MEMORY SPAN

Directions: Now this is a similar game except this time I am going to say what could be parts of words instead of letters.

Listen carefully

1. sut

   tid

   fen

2. ba gard

   be haps

   bro ter

3. for id sult

   ex plete ly

   in fas try

4. sim tur son dle

   val es pen cal

   ad day pic ord

5. la jec te ri al

   per di on sup low

   fe pro mis cep tice

6. dis ap pose hap li mous

   can er bet un var tance

   rap unc to pub lem id

7. won di mu scand lic yond din

   ap to get i graph al ly

   pleas a quar ten du dent er

Score the highest number of syllables correctly produced.
Score the highest number of nonsense words correctly produced.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

APPENDIX D

I. t-tests for the Significance of Differences between Means of High and Low Auditory Discriminators

II. Correlation Coefficients for the Kindergarten and Grade One.

TABLE D.1

MEANS AND STANDARD DEVIATIONS ON AUDITORY ABILITIES AND READING ACHIEVEMENT OF HIGH AND LOW DISCRIMINATORS IN KINDERGARTEN
N=100

Variable	Mean H.D. N=60	Mean L.D. N=40	SDev. H.D.	SDev. L.D.	Mean Adj.DF	Mean t'	P	Sign
1. Age	71.56	69.31	3.46	2.99	89.39	3.447	0.001	**
2. Memory for letters forward	3.02	2.54	1.20	1.47	69.63	1.702	0.093	NS
3. Memory for letters backward	1.70	.69	1.16	1.08	85.32	4.443	0.001	**
4. Total memory for letters	4.72	3.15	1.85	2.12	72.84	3.788	0.001	**
5. Memory for syllables	3.59	3.23	.90	.74	91.79	2.170	0.032	*
6. Total memory span	8.23	6.46	2.11	2.38	73.86	3.783	0.001	**
7. Discrimination Test 1	41.89	23.67	4.74	10.16	48.73	10.491	0.001	**
8. Test 2	39.46	21.23	6.78	9.25	63.81	10.618	0.001	**
9. Test 3	39.43	23.10	5.08	8.32	56.26	11.003	0.001	**
10. Test 4	39.26	24.74	4.89	9.70	50.49	8.658	0.001	**
11. Test 5	35.05	24.41	5.09	8.13	57.14	7.309	0.001	**
12. Total auditory discrimination	194.54	116.46	15.55	39.81	45.50	11.692	0.001	**
13. Total acuity left	53.77	79.36	34.36	120.38	41.99	-1.294	0.203	NS
14. Total acuity right	55.08	75.90	34.89	113.86	42.60	-1.109	0.274	NS
15. Total acuity	108.85	155.51	65.44	233.12	41.86	-1.220	0.229	NS
16. Total low frequencies	32.05	48.08	23.51	63.88	44.65	-1.503	0.139	NS
17. Total middle frequencies	46.07	71.54	29.65	121.68	40.90	-1.283	0.206	NS
18. Total high frequencies	29.92	37.56	20.34	55.44	44.61	-0.826	0.412	NS
19. Vocabulary (Gates)	22.10	15.62	7.25	4.54	97.97	5.496	0.001	**
20. Comprehension	20.90	14.95	7.20	3.49	92.52	5.520	0.001	**
21. Slosson	15.77	10.62	8.78	4.96	96.79	3.746	0.001	**
22. Word Accuracy (Neale)	86.79	79.33	8.07	14.61	52.99	2.914	0.005	**
23. Comprehension	83.31	77.10	7.61	13.16	54.42	2.674	0.009	**

"t'" is a Welch approximation

** p <.01
* p <.05

TABLE D.2

MEANS AND STANDARD DEVIATIONS ON AUDITORY ABILITIES, READING ACHIEVEMENT, INTELLIGENCE AND RELATED VARIABLES OF HIGH AND LOW DISCRIMINATORS IN GRADE ONE

N=100

Variable	Mean H.D. N=62	Mean L.D. N=38	SDev. H.D.	SDev. L.D.	Mean Adj.DF	Mean t'	Mean P	Sign
1. Age	76.40	76.11	5.61	3.34	97.98	0.332	0.740	NS
2. Memory for letters forward	3.50	3.03	0.72	1.00	60.47	2.546	0.013	**
3. Memory for letters backward	2.21	1.58	0.91	1.24	61.14	2.714	0.008	**
4. Total memory for letters	5.76	4.61	1.29	1.87	58.72	3.347	0.001	**
5. Memory for syllables	3.60	3.32	0.61	0.53	87.54	2.434	0.016	*
6. Total memory span	9.29	7.92	1.51	2.06	61.33	3.557	0.001	**
7. Discrimination Test 1	45.05	32.24	4.07	8.83	46.77	8.414	0.001	**
8. Test 2	43.50	30.24	4.50	8.03	51.49	9.324	0.001	**
9. Test 3	43.97	31.89	6.46	7.75	67.76	8.044	0.001	**
10. Test 4	44.47	32.79	6.30	8.14	63.88	7.565	0.001	**
11. Test 5	43.24	32.08	6.47	8.31	64.24	7.068	0.001	**
12. Total auditory discrimination	219.08	159.26	30.66	35.27	70.09	8.643	0.001	**
13. Total acuity left	40.48	41.97	30.09	59.21	48.90	-0.144	0.886	NS
14. Total acuity right	41.94	45.79	42.18	71.77	52.89	-0.301	0.764	NS
15. Total acuity	82.42	87.76	65.69	129.15	48.92	-0.237	0.813	NS
16. Language in home	1.81	1.47	0.40	0.51	64.77	3.451	0.001	**
17. Logical reasoning	25.81	23.08	5.41	4.92	84.07	2.589	0.011	**
18. Numerical reasoning	14.18	11.87	3.55	3.06	80.26	3.620	0.001	**

TABLE D.2 (continued)

Variable	Mean H.D. N=62	Mean L.D. N=38	SDev. H.D.	SDev. L.D.	Mean Adj.DF	Mean t'	Mean P	Sign
19. Verbal comprehension	17.71	15.29	3.28	3.94	67.75	3.173	0.002	**
20. Delayed memory	8.50	6.05	2.87	2.72	81.71	4.274	0.001	**
21. Language	32.53	26.55	6.28	6.56	75.74	4.495	0.001	**
22. Non-Language	33.69	29.74	6.14	5.99	79.94	3.178	0.002	**
23. Total language	66.23	56.32	11.24	11.07	79.32	4.319	0.001	**
24. Intelligence quotient language	110.47	99.29	13.07	10.61	90.40	4.673	0.001	**
25. I.Q. non-language	112.21	104.79	12.72	9.57	93.78	3.312	0.001	**
26. Total I.Q.	112.16	102.03	12.84	9.35	95.00	4.551	0.001	**
27. Mental age language	84.47	75.82	9.50	8.48	85.18	4.727	0.001	**
28. Mental age non-language	85.81	79.63	9.20	8.57	82.71	3.400	0.001	**
29. Total mental age	85.69	77.63	9.15	7.83	87.60	4.684	0.001	**
30. Total unlike word-pairs	171.37	112.18	10.49	40.65	40.04	8.798	0.001	**
31. Total low frequencies	30.47	28.82	22.70	32.01	59.86	-0.278	0.781	NS
32. Total middle frequencies	34.27	37.76	32.74	58.31	51.52	-0.338	0.651	NS
33. Total high frequencies	17.98	21.32	19.62	42.52	46.80	-0.454	0.651	NS
34. Vocabulary (Gates-MacGinitie)	21.53	15.89	7.54	5.52	94.69	4.307	0.001	**
35. Comprehension	21.53	15.13	8.59	3.73	90.21	5.131	0.001	**
36. Slosson	15.84	10.66	8.78	6.24	95.73	3.440	0.001	**
37. Word recognition(Neale)	85.81	79.05	11.63	14.75	64.87	2.401	0.019	*
38. Comprehension	82.39	76.97	12.80	13.29	76.13	2.005	0.048	*

"t'" is a Welch approximation

** $p < .01$
* $p < .05$

TABLE D.3

MEANS AND STANDARD DEVIATIONS ON AUDITORY ABILITIES, READING ACHIEVEMENT, INTELLIGENCE AND RELATED VARIABLES OF HIGH AND LOW DISCRIMINATORS IN CONSTANT GROUP
N=77

Variable	Mean H.D. N=45	Mean L.D. N=32	SDev. H.D.	SDev. L.D.	Mean Adj.DF	Mean t'	Mean P	Sign
1. Age	76.50	75.22	6.34	3.06	65.87	1.212	0.229	NS
2. Memory for letters forward	3.53	2.91	.79	1.24	31.31	2.185	0.036	*
3. Memory for letters backward	2.29	1.09	.84	1.20	33.37	4.285	0.001	**
4. Total memory for letters	5.89	4.00	1.28	2.04	31.12	4.042	0.003	**
5. Memory for syllables	3.67	3.22	.64	.42	61.58	3.464	0.001	**
6. Total memory span	9.47	7.22	1.50	2.15	33.28	4.485	0.001	**
7. Discrimination Test 1	45.00	30.52	4.36	8.21	28.52	7.908	0.001	**
8. Test 2	43.62	30.00	4.79	8.71	28.98	6.983	0.001	**
9. Test 3	43.73	31.09	7.28	7.63	42.61	6.570	0.001	**
10. Test 4	44.22	32.78	7.24	8.31	39.44	5.605	0.001	**
11. Test 5	43.31	31.30	7.32	8.50	39.04	5.770	0.001	**
12. Total auditory discrimination	218.31	155.74	35.35	35.16	44.64	6.930	0.001	**
13. Total acuity left	40.11	45.22	32.01	71.10	26.65	-0.328	0.745	NS
14. Total acuity right	42.67	50.00	47.25	86.54	28.88	-0.379	0.707	NS
15. Total acuity	82.78	95.22	73.16	156.40	27.03	-0.362	0.720	NS
16. Language in home	1.84	1.39	0.37	0.50	37.49	3.856	0.001	**
17. Logical reasoning	27.44	21.58	4.36	4.92	39.98	4.665	0.001	**
18. Numerical reasoning	14.62	11.13	2.99	3.43	39.41	4.146	0.001	**
19. Verbal comprehension	18.31	14.09	2.90	4.37	32.20	4.190	0.001	**
20. Delayed memory	8.98	5.57	2.73	2.71	44.66	4.902	0.001	**

TABLE D.3 (continued)

Variable	Mean H.D. N=45	Mean L.D. N=32	SDev. H.D.	SDev. L.D.	Mean Adj.DF	Mean t'	Mean P	Mean Sign
21. Language	33.91	24.74	5.73	6.98	37.55	5.438	0.001	**
22. Non-language	35.42	27.83	5.09	5.88	39.18	5.267	0.001	**
23. Total language	69.33	52.61	9.53	11.74	37.19	5.909	0.001	**
24. I.Q. language	112.62	96.78	12.59	10.53	52.03	5.484	0.001	**
25. I.Q. non-language	115.20	101.60	12.09	7.69	62.69	5.637	0.001	**
26. Total I.Q.	114.98	99.30	12.12	8.94	57.41	6.037	0.001	**
27. Mental age language	86.49	73.26	9.26	8.26	49.15	5.992	0.001	**
28. Mental age non-language	88.38	76.52	8.36	7.29	50.19	6.092	0.001	**
29. Total mental age	88.16	74.91	8.38	7.72	47.82	6.502	0.001	**
30. Total unlike word-pairs	172.00	105.78	10.80	38.80	23.76	8.072	0.001	**
31. Total low frequencies	30.31	32.39	24.87	37.47	32.20	-0.241	0.811	NS
32. Total middle frequencies	33.89	39.13	36.71	70.37	28.27	-0.335	0.740	NS
33. Total high frequencies	18.89	23.91	21.32	52.07	25.84	-0.444	0.660	NS
34. Vocabulary (Gates)	22.58	14.26	8.02	4.49	65.34	5.476	0.001	**
35. Comprehension	23.18	13.96	9.23	3.48	62.28	5.929	0.001	**
36. Slosson	16.76	9.35	9.33	4.22	65.33	4.503	0.001	**
37. Word recognition (Neale)	86.38	76.43	12.96	17.77	34.32	2.379	0.023	*
38. Comprehension	83.16	74.96	14.80	16.64	40.12	1.994	0.053	*

"t'" is a Welch approximation

** p < .01
* p < .05

TABLE D.4

MEANS AND STANDARD DEVIATIONS ON AUDITORY ABILITIES, READING ACHIEVEMENT, INTELLIGENCE AND RELATED VARIABLES OF HIGH AND LOW DISCRIMINATORS IN INCONSTANT GROUP

N=32

Variable	Mean H.D. N=17	Mean L.D. N=15	SDev. H.D.	SDev. L.D.	Mean Adj.DF	Mean t'	Mean P	Sign
1. Age	75.88	77.47	3.02	3.46	28.04	-1.371	0.181	NS
2. Memory for letters forward	3.41	3.20	.51	.41	29.84	1.299	-0.087	
3. Memory for letters backward	2.00	2.33	1.06	.90	29.96	-0.962	0.343	NS
4. Total memory for letters	5.41	5.53	1.28	1.06	29.90	-0.294	0.770	NS
5. Memory for syllables	3.41	3.47	.51	.64	26.66	-0.267	0.791	NS
6. Total memory span	8.82	9.00	1.47	1.36	29.91	-0.353	0.726	NS
7. Discrimination Test 1	45.18	34.87	3.26	9.38	16.98	4.046	0.001	**
8. Test 2	43.18	30.60	3.76	7.14	20.62	6.114	0.001	**
9. Test 3	44.59	33.13	3.59	8.03	18.85	5.092	0.001	**
10. Test 4	45.12	32.80	2.50	8.17	16.31	5.613	0.001	**
11. Test 5	43.06	33.27	3.53	8.16	18.55	4.305	0.001	**
12. Total auditory discrimination	221.12	164.67	11.91	35.95	16.71	5.806	0.001	**
13. Total acuity left	41.47	37.00	25.17	35.75	24.78	0.404	0.689	NS
14. Total acuity right	40.00	39.33	25.25	42.08	22.33	0.053	0.957	NS
15. Total acuity	81.47	76.33	41.56	73.57	21.50	0.239	0.406	NS
16. Language in home	1.71	1.60	.47	.51	28.78	0.610	0.546	NS
17. Logical reasoning	21.47	25.07	5.64	4.37	29.55	-2.030	0.051	*
18. Numerical reasoning	13.00	13.00	3.37	2.00	26.49	0.0	1.000	
19. Verbal comprehension	16.12	17.13	3.77	2.23	26.45	-0.939	0.356	NS
20. Delayed memory	7.24	6.80	2.95	2.65	29.98	0.440	0.663	NS

TABLE D.4 (continued)

Variable	Mean H.D. N=17	Mean L.D. N=15	SDev. H.D.	SDev. L.D.	Mean Adj.DF	Mean t'	Mean P	Mean Sign
21. Language	28.88	29.33	6.38	4.86	29.43	-0.226	0.822	NS
22. Non-language	29.12	32.67	6.47	5.01	29.54	-1.745	0.091	NS
23. Total language	58.00	62.00	11.54	7.08	26.95	-1.196	0.242	NS
24. I.Q. language	104.76	103.13	12.96	9.87	29.42	0.403	0.689	NS
25. I.Q. non-language	104.29	109.67	11.09	10.36	29.89	-1.417	0.166	NS
26. Total I.Q.	104.71	106.20	11.97	8.63	28.93	-0.408	0.686	NS
27. Mental age language	79.12	79.73	8.15	7.47	29.95	-0.223	0.825	NS
28. Mental age non-language	79.00	84.40	7.91	8.38	28.98	-1.868	0.072	NS
29. Total mental age	79.18	81.80	7.99	6.14	29.50	-1.048	0.303	NS
30. Total unlike word-pairs	169.71	122.00	9.74	42.78	15.28	4.223	0.001	**
31. Total low frequencies	30.88	23.33	16.22	21.19	26.12	1.120	0.272	NS
32. Total middle frequencies	35.29	35.67	19.48	34.58	21.47	-0.037	0.970	NS
33. Total high frequencies	15.59	17.33	14.46	22.11	23.62	-0.260	0.796	NS
34. Vocabulary (Gates)	18.76	18.40	5.23	6.14	27.71	0.180	0.858	NS
35. Comprehension	17.18	16.93	4.42	3.45	29.60	0.174	0.862	NS
36. Slosson	13.41	12.67	6.77	8.24	27.20	0.277	0.783	NS
37. Word accuracy (Neale)	84.29	83.07	7.11	7.09	29.53	0.488	0.629	NS
38. Comprehension	80.35	80.07	4.00	3.83	29.78	0.207	0.886	NS

"t'" is a Welch approximation

** $p < .01$
* $p < .05$

TABLE D.5

COEFFICIENTS OF CORRELATIONS
KINDERGARTEN
N=100

Variable	1	2	3	4	5	6
1. Sex		0.119	0.002	0.051	0.017	-0.131
2. Age			-0.087	0.243*	0.094	-0.016
3. Aud. memory for letters forward				0.293**	0.804**	0.024
4. Aud. memory for letters backward					0.788**	0.336**
5. Total aud. memory for letters						0.220*
6. Aud. memory for syllables						
7. Total auditory memory span						
8. Auditory discrimination Test 1						
9. Test 2						
10. Test 3						
11. Test 4						
12. Test 5						
13. Total auditory distrimination						
14. Total acuity left ear						
15. Total acuity right ear						
16. Total acuity						
17. Total low frequencies						
18. Total middle frequencies						
19. Total high frequencies						
20. Vocabulary (Gates)						
21. Comprehension						
22. Slosson (sixth month)						
23. Word accuracy (Neale)						
24. Comprehension						
25. Slosson (third month)						
26. Reading Program						

TABLE D.5 (continued)

Variable	7	8	9	10	11	12
1. Sex	0.001	-0.142	-0.149	-0.054	-0.115	-0.047
2. Age	0.076	0.299**	0.218*	0.266**	0.272**	0.142
3. Aud. memory for letters forward	0.765**	0.050	0.203*	0.097	0.022	0.128
4. Aud. memory for letters backward	0.774**	0.335**	0.352**	0.338**	0.293**	0.312**
5. Total aud. memory for letters	0.948**	0.260**	0.362**	0.284**	0.217*	0.295**
6. Aud. memory for syllables	0.436**	0.207*	0.264**	0.244*	0.168	0.340**
7. Total auditory memory span		0.269**	0.388**	0.311**	0.218*	0.330**
8. Auditory Discrimination Test 1			0.801**	0.817**	0.814**	0.681**
9. Test 2				0.793**	0.777**	0.736**
10. Test 3					0.830**	0.727**
11. Test 4						0.715**
12. Test 5						
13. Total auditory discrimination						
14. Total acuity left ear						
15. Total acuity right ear						
16. Total acuity						
17. Total low frequencies						
18. Total middle frequencies						
19. Total high frequencies						
20. Vocabulary (Gates)						
21. Comprehension						
22. Slosson (Sixth month)						
23. Word accuracy (Neale)						
24. Comprehension						
25. Slosson (third month)						
26. Reading Program						

TABLE D.5 (continued)

Variable	13	14	15	16	17	18
1. Sex	-0.115	0.076	0.040	0.059	0.019	0.058
2. Age	0.268**	0.049	0.021	0.036	0.028	0.033
3. Aud. memory for letters forward	0.115	-0.082	-0.057	-0.070	-0.028	-0.059
4. Aud. memory for letters backward	0.364**	-0.022	0.016	-0.003	0.003	0.014
5. Total aud. memory for letters	0.318**	-0.057	-0.019	-0.038	-0.010	-0.022
6. Aud. memory for syllables	0.273**	-0.138	-0.092	-0.116	-0.077	-0.111
7. Total auditory memory span	0.341**	-0.109	-0.067	-0.089	-0.052	-0.071
8. Auditory discrimination Test 1	0.912**	-0.223	-0.208	-0.218	-0.248	-0.206
9. Test 2	0.910**	-0.153	-0.135	-0.146	-0.166	-0.153
10. Test 3	0.923**	-0.275	-0.266	-0.274	-0.293	-0.274
11. Test 4	0.917**	-0.102	-0.118	-0.111	-0.150	-0.113
12. Test 5	0.843**	-0.121	-0.100	-0.112	-0.137	-0.112
13. Total auditory discrimination		-0.190	-0.179	-0.187	-0.216	-0.188
14. Total acuity left ear			0.952**	0.988**	0.944**	0.972**
15. Total acuity right ear				0.987**	0.938**	0.978**
16. Total acuity					0.954**	0.988**
17. Total low frequencies						0.936**
18. Total middle frequencies						
19. Total high frequencies						
20. Vocabulary (Gates)						
21. Comprehension						
22. Slosson (sixth month)						
23. Word accuracy (Neale)						
24. Comprehension						
25. Slosson (third month)						
26. Reading Program						

TABLE D.5 (continued)

Variable	19	20	21	22	23	24	25	26
1. Sex	0.064	0.087	0.160	0.131	0.187	0.190	0.149	0.047
2. Age	0.049	0.235*	0.285**	0.226*	0.231*	0.248*	0.133	0.072
3. Aud.memory for letters forward	-0.112	0.167	0.100	0.182	0.134	0.161	0.156	-0.056
4. Aud.memory for letters backward	-0.045	0.302**	0.356**	0.335**	0.348**	0.288**	0.352	0.134
5. Total aud. memory for letters	-0.088	0.290**	0.276**	0.310**	0.284**	0.268**	0.302**	0.018
6. Aud. memory for syllables	-0.135	0.094	0.055	0.058	0.069	0.002	0.077	-0.013
7. Total auditory memory span	-0.137	0.270**	0.252**	0.290**	0.269**	0.246*	0.288**	0.032
8. Auditory discrimination Test 1	-0.173	0.380**	0.399**	0.231*	0.333**	0.361**	0.189	0.036
9. Test 2	-0.097	0.407**	0.409**	0.273**	0.367**	0.396**	0.256**	0.059
10. Test 3	-0.214	0.444**	0.451**	0.307**	0.422**	0.442**	0.235*	-0.009
11. Test 4	-0.041	0.385**	0.386**	0.272**	0.386**	0.419**	0.263**	0.029
12. Test 5	-0.075	0.343**	0.362**	0.212*	0.380**	0.433**	0.168	-0.063
13. Total auditory discrimination	-0.127	0.442**	0.452**	0.294*	0.417**	0.455**	0.248*	0.002
14. Total acuity left ear	0.945**	0.059	0.086	0.141	0.074	0.030	0.121	0.166
15. Total acuity right ear	0.944**	0.041	0.065	0.126	0.079	0.038	0.122	0.166
16. Total acuity	0.956**	0.051	0.077	0.136	0.077	0.035	0.123	0.168
17. Total low frequencies	0.852**	0.138	0.156	0.219	0.108	0.044	0.173	0.155
18. Total middle frequencies	0.924**	0.018	0.049	0.108	0.068	0.030	0.106	0.180
19. Total high frequencies		-0.000	0.024	0.080	0.058	0.039	0.072	0.143
20. Vocabulary (Gates)			0.881**	0.874**	0.766**	0.646**	0.764**	0.163
21. Comprehension				0.860**	0.744**	0.686**	0.705**	0.180
22. Slosson (sixth month)					0.728**	0.574**	0.840**	0.319**
23. Word accuracy (Neale)						0.896**	0.645**	0.128
24. Comprehension							0.525**	0.010
25. Slosson (third month)								0.381**
26. Reading Program								

** p < .01
* p < .05

TABLE D.6

COEFFICIENTS OF CORRELATIONS
GRADE ONE
N=100

Variable	1	2	3	4	5
1. Sex	-	0.144	0.158	0.063	0.127
2. Age			0.127	0.283**	0.261**
3. Aud. memory for letters forward				9.339**	0.759**
4. Aud. memory for letters backward					0.856**
5. Total aud memory for letters					
6. Aud. memory for syllables					
7. Total auditory memory span					
8. Auditory discrimination Test 1					
9. Test 2					
10. Test 3					
11. Test 4					
12. Test 5					
13. Total auditory discrimination					
14. Total acuity left ear					
15. Total acuity right ear					
16. Total acuity'					
17. Total low frequencies					
18. Total middle frequencies					
19. Total high frequencies					
20. Language environment in home					
21. Number in family					
22. Position in family					
23. Logical reasoning					
24. Numerical reasoning					
25. Verbal comprehension					
26. Delayed memory					
27. I.Q. language					
28. I.Q. Non-language					
29. Total I.Q.					
30. Mental age language					
31. Mental age Non-language					
32. Total mental age					
33. Vocabulary (Gates)					
34. Comprehension					
35. Slosson (sixth month)					
36. Word accuracy (Neale)					
37. Comprehension					
38. Slosson (third month)					
39. Reading Program					

TABLE D.6 (Continued)

Variable	6	7	8	9	10
1. Sex	0.216*	0.179	0.034	0.014	0.034
2. Age	0.058	0.243*	0.115	0.148	0.138
3. Memory for letters forward	0.253**	0.733**	0.227*	0.266**	0.241*
4. Memory for letters backward	0.224*	0.897**	0.254**	0.225*	0.243*
5. Total memory for letters	0.288**	0.942**	0.295**	0.295**	0.295**
6. Memory for syllables		0.565**	0.194	0.194	0.219*
7. Total memory span			0.316**	0.316**	0.324**
8. Discrimination Test 1				0.829**	0.826**
9. Test 2					0.830**
10. Test 3					
11. Test 4					
12. Test 5					
13. Total discrimination					
14. Total acuity left ear					
15. Total acuity right ear					
16. Total acuity					
17. Total low frequencies					
18. Total middle frequencies					
19. Total high frequencies					
20. Language in home					
21. Number in family					
22. Position in family					
23. Logical reasong					
24. Numerical reasoning					
25. Verbal comprehension					
26. Dalayed memory					
27. I.Q. language					
28. I.Q. Non-language					
29. Total I.Q.					
30. Mental age language					
31. Mental age Non-language					
32. Total mental age					
33. Vocabulary (Gates)					
34. Comprehension					
35. Slosson (sixth month)					
36. Word accuracy (Neale)					
37. Comprehension					
38. Slosson (third month)					
39. Reading Program					

TABLE D.6 (continued)

Variable	11	12	13	14	15
1. Sex	-0.061	-0.012	-0.012	-0.045	-0.113
2. Age	0.074	0.160	0.139	0.012	-0.073
3. Memory for letters forward	0.234*	0.112	0.234*	0.066	0.150
4. Memory for letters backward	0.244*	0.137	0.239*	-0.212	-0.144
5. Total memory for letters	0.292**	0.153	0.288**	-0.109	-0.018
6. Memory for syllables	0.214*	0.222*	0.225*	-0.033	-0.002
7. Total memory span	0.319**	0.203	0.319**	-0.105	-0.016
8. Discrimination Test 1	0.793**	0.791**	0.915**	-0.041	-0.057
9. Test 2	0.791**	0.824**	0.922**	-0.070	-0.095
10. Test 3	0.830**	0.827**	0.928**	0.048	0.007
11. Test 4		0.797**	0.905**	0.009	0.030
12. Test 5			0.912**	-0.001	-0.044
13. Total discrimination				-0.015	-0.035
14. Total acuity left ear					0.834**
15. Total acuity right ear					
16. Total acuity					
17. Total low frequencies					
18. Total middle frequencies					
19. Total high frequencies					
20. Language in home					
21. Number in family					
22. Position in family					
23. Logical reasoning					
24. Numerical reasoning					
25. Verbal comprehension					
26. Delayed memory					
27. I.Q. Language					
28. I.Q. Non-language					
29. Total I.Q.					
30. Mental age Language					
31. Mental age Non-language					
32. Total mental age					
33. Vocabulary (Gates)					
34. Comprehension					
35. Slosson (sixth month)					
36. Word accuracy (Neale)					
37. Comprehension					
38. Slosson (third month)					
39. Reading Program					

TABLE D.6 (continued)

Variable	16	17	18	19	20
1. Sex	-0.086	-0.040	-0.104	-0.096	-0.134
2. Age	-0.037	-0.031	-0.010	-0.063	0.041
3. Memory for letters forward	0.118	0.097	0.117	0.112	0.148
4. Memory for letters backward	-0.181	-0.232	-0.138	-0.182	0.209
5. Total memory for letters	-0.061	-0.106	-0.031	-0.064	0.222*
6. Memory for syllables	-0.016	-0.055	0.010	-0.032	0.167
7. Total memory span	-0.057	-0.109	-0.023	-0.066	0.244**
8. Distrimination Test 1	-0.052	-0.025	-0.054	-0.073	0.281**
9. Test 2	-0.087	-0.042	-0.097	-0.990	0.250**
10. Test 3	0.026	0.051	0.013	0.007	0.335**
11. Test 4	0.022	0.065	-0.009	0.018	0.349**
12. Test 5	-0.030	-0.004	-0.045	-0.037	0.344**
13. Total discrimination	-0.027	0.008	-0.042	-0.043	0.335**
14. Total acuity left ear	0.939**	0.898**	0.880**	0.897**	0.053
15. Total acuity right ear	0.959**	0.842**	0.956**	0.894**	0.088
16. Total acuity		0.903**	0.961	0.932**	0.076
17. Total low frequencies			0.822**	0.790**	0.040
18. Total middle frequencies				0.868**	0.057
19. Total high frequencies					0.113
20. Language in home					
21. Number in family					
22. Position in family					
23. Logical reasoning					
24. Numerical reasoning					
25. Verbal comprehension					
26. Delayed memory					
27. I.Q. Language					
28. I.Q. Non Language					
29. Total I.Q.					
30. Mental age Language					
31. Mental age Non-language					
32. Total mental age					
33. Vocabulary (Gates)					
34. Comprehension					
35. Slosson (sixth month)					
36. Word accuracy (Neale)					
37. Comprehension					
38. Slosson (third month)					
39. Reading Program					

TABLE D.6 (continued)

Variable	21	22	23	24	25
1. Sex	-0.079	0.065	0.109	0.128	0.051
2. Age	-0.022	0.055	0.300**	0.347**	0.223*
3. Memory for letters forward	0.015	-0.117	0.191	0.255**	0.229*
4. Memory for letters backward	-0.061	0.055	0.328**	0.480**	0.279**
5. Total memory for letters	-0.033	-0.024	0.326**	0.464**	0.313**
6. Memory for syllables	0.201	-0.058	0.260**	0.210*	0.091
7. Total memory span	0.035	-0.039	0.363**	0.465**	0.298**
8. Discrimination Test 1	-0.027	-0.104	0.227*	0.285**	0.351**
9. Test 2	-0.033	0.013	0.238*	0.280**	0.352**
10. Test 3	0.019	-0.040	0.262**	0.315**	0.390**
11. Test 4	0.045	-0.005	0.213*	0.233**	0.271**
12. Test 5	0.037	-0.069	0.277**	0.335**	0.368**
13. Total discrimination	0.007	-0.045	0.263**	0.312**	0.375**
14. Total acuity left ear	-0.032	-0.047	-0.134	-0.091	0.039
15. Total acuity right ear	0.065	0.020	-0.114	-0.068	0.003
16. Total acuity	0.023	-0.009	-0.128	-0.082	0.020
17. Total low frequencies	-0.010	-0.060	-0.189	-0.112	0.014
18. Total middle frequencies	0.027	0.020	-0.095	-0.054	0.040
19. Total high frequencies	0.048	-0.007	-0.114	-0.085	-0.013
20. Language in home	0.028	-0.171	0.264**	0.378**	0.345**
21. Number in family		-0.134	-0.022	-0.100	-0.143
22. Position in family			0.039	0.068	-0.111
23. Logical reasoning				0.478**	0.522**
24. Numerical reasoning					0.366**
25. Verbal comprehension					
26. Delayed memory					
27. I.Q. Language					
28. I.Q. Non-language					
29. Total I.Q.					
30. Mental age Language					
31. Mental age Non-language					
32. Total mental age					
33. Vocabulary (Gates)					
34. Comprehension					
35. Slosson (sixth month)					
36. Word accuracy (Neale)					
37. Comprehension					
38. Slosson (third month)					
39. Reading Program					

TABLE D.6 (continued)

Variable	26	27	28	29	30
1. Sex	0.018	0.010	0.046	0.021	0.065
2. Age	0.128	-0.002	0.041	-0.011	0.370**
3. Memory for letters forward	0.186	0.210	0.183	0.217*	0.232*
4. Memory for letters backward	0.321**	0.319**	0.332**	0.347**	0.396**
5. Total memory for letters	0.319**	0.330**	0.324**	0.352**	0.394**
6. Memory for syllables	0.105	0.120	0.281**	0.194	0.121
7. Total memory span	0.307**	0.322**	0.369**	0.365**	0.377**
8. Discrimination Test 1	0.293**	0.363**	0.278**	0.352**	0.370**
9. Test 2	0.294**	0.369**	0.266**	0.351**	0.391**
10. Test 3	0.335**	0.401**	0.295**	0.385**	0.414**
11. Test 4	0.314**	0.335**	0.248**	0.322**	0.331**
12. Test 5	0.378**	0.418**	0.307**	0.400**	0.441**
13. Total discrimination	0.347**	0.407**	0.301**	0.390**	0.420**
14. Total acuity left ear	-0.074	-0.056	-0.119	-0.095	-0.038
15. Total acuity right ear	0.014	0.016	-0.098	-0.035	-0.006
16. Total acuity	-0.025	-0.016	-0.112	-0.064	-0.021
17. Total low frequencies	-0.051	-0.049	-0.157	-0.108	-0.047
18. Total middle frequencies	0.012	-0.025	-0.093	-0.031	0.026
19. Total high frequencies	-0.063	0.055	-0.096	-0.076	-0.070
20. Language in time	0.435**	0.445**	0.370**	0.450**	0.419**
21. Number in family	-0.043	-0.128	-0.071	-0.113	-0.127
22. Position in family	-0.049	-0.061	0.052	-0.011	-0.032
23. Logical reasoning	0.430**	0.518**	0.885**	0.767**	0.590**
24. Numerical reasoning	0.554**	0.574**	0.609**	0.646**	0.665**
25. Verbal comprehension	0.519**	0.773**	0.491**	0.698**	0.791**
26. Delayed memory		0.842**	0.478**	0.745**	0.829**
27. I.Q. Language			0.602**	0.894**	0.914**
28. I.Q. Non-language				0.872**	0.572**
29. Total I.Q.					0.824**
30. Mental age Language					
31. Mental age Non-language					
32. Total mental age					
33. Vocabulary (Neale)					
34. Comprehension					
35. Slosson (sixth month)					
36. Word accuracy (Neale)					
37. Comprehension					
38. Slosson (third month)					
39. Reading Program					

TABLE D.6 (continued)

Variable	31	32	33	34	35
1. Sex	0.101	0.080	0.118	0.180	0.146
2. Age	0.453**	0.392**	0.227*	0.279**	0.218*
3. Memory for letters forward	0.212*	0.243**	0.170	0.234*	0.151
4. Memory for letters backward	0.414**	0.425**	0.335**	0.338**	0.275**
5. Total memory for letters	0.396**	0.420**	0.319**	0.355**	0.268**
6. Memory for syllables	0.283**	0.198	0.138**	0.192	0.142
7. Total memory span	0.430**	0.424**	0.318**	0.367**	0.276**
8. Discrimination Test 1	0.297**	0.369**	0.315**	0.349**	0.246**
9. Test 2	0.293**	0.386**	0.435**	0.451**	0.368**
10. Test 3	0.313**	0.412**	0.423**	0.430**	0.354**
11. Test 4	0.252**	0.331**	0.329**	0.365**	0.265**
12. Test 5	0.332**	0.436**	0.444**	0.450**	0.338**
13. Total discrimination	0.321**	0.417**	0.415**	0.441**	0.339**
14. Total acuity left ear	-0.106	-0.082	-0.050	0.003	0.073
15. Total acuity right ear	-0.120	-0.064	-0.056	0.004	0.070
16. Total acuity	-0.118	-0.075	-0.056	0.003	0.074
17. Total low frequencies	-0.157	-0.109	-0.049	0.030	0.062
18. Total middle frequencies	-0.090	-0.035	-0.039	0.005	0.096
19. Total high frequencies	-0.114	-0.099	-0.038	0.050	0.015
20. Language in home	0.339**	0.427**	0.390**	0.314**	0.276**
21. Number in family	-0.080	-0.114	-0.103	-0.005	-0.132
22. Position in family	0.076	0.008	-0.019	-0.044	0.048
23. Logical reasoning	0.909**	0.817**	0.474**	0.458**	0.396**
24. Numerical reasoning	0.691**	0.737**	0.473**	0.475**	0.400**
25. Verbal comprehension	0.527**	0.734**	0.567**	0.488**	0.429**
26. Delayed memory	0.474**	0.733**	0.492**	0.447**	0.328**
27. I.Q. Language	0.532**	0.822**	0.580**	0.529**	0.434**
28. I.Q. Non-language	0.892**	0.812**	0.488**	0.438**	0.394**
29. Total I.Q.	0.767**	0.902**	0.578**	0.526**	0.440**
30. Mental age Language	0.665**	0.911**	0.624**	0.603**	0.488**
31. Mental age Non-language		0.887**	0.531**	0.507**	0.448**
32. Total mental age			0.627**	0.598**	0.496**
33. Vocabulary (Gates)				0.872**	0.865**
34. Comprehension					0.851**
35. Slosson (sixth month)					
36. Word accuracy (Neale)					
37. Comprehension					
38. Slosson (third month)					
39. Reading Program					

TABLE D.6 (continued)

Variable	36	37	38	39
1. Sex	0.193	0.189	0.169	0.012
2. Age	0.225*	0.245**	0.130	0.080
3. Memory for letters forward	0.381**	0.357**	0.145	-0.001
4. Memory for letters backward	0.351**	0.305**	0.272**	0.135
5. Total memory for letters	0.443*	0.399**	0.263**	0.091
6. Memory for syllables	0.162	0.160	0.106	-0.152
7. Total memory span	0.432**	0.394**	0.260**	0.029
8. Discrimination Test 1	0.270**	0.270**	0.217*	-0.153
9. Test 2	0.336**	0.295**	0.314**	-0.130
10. Test 3	0.369**	0.314**	0.279**	-0.142
11. Test 4	0.287**	0.277**	0.192	-0.207
12. Test 5	0.402**	0.398**	0.275**	-0.211
13. Total discrimination	0.359**	0.335**	0.276**	-0.181
14. Total acuity left ear	-0.009	-0.024	0.078	0.124
15. Total acuity right ear	0.047	0.037	0.048	0.108
16. Total acuity	0.023	0.010	0.064	0.120
17. Total low frequencies	-0.041	-0.054	0.064	0.039
18. Total middle frequencies	0.043	0.029	0.067	0.138
19. Total high frequencies	0.031	0.017	0.015	0.134
20. Language in home	0.332**	0.264**	0.330**	-0.033
21. Number in family	-0.013	0.066	-0.247	-0.174
22. Position in family	-0.061	-0.111	0.023	0.027
23. Logical reasoning	0.499**	0.512**	0.363**	0.034
24. Numerical reasoning	0.543**	0.522**	0.387**	0.063
25. Verbal comprehension	0.534**	0.483**	0.361**	-0.029
26. Delayed memory	0.462**	0.445**	0.311**	0.030
27. I.Q. Language	0.542**	0.529**	0.379**	-0.025
28. I.Q. Non-language	0.475**	0.460**	0.411**	0.035
29. Total I.Q.	0.553**	0.541**	0.420**	-0.006
30. Mental age Language	0.578**	0.577**	0.379**	0.012
31. Mental age Non-language	0.512**	0.509**	0.426**	0.070
32. Total mental age	0.592**	0.593**	0.439**	0.024
33. Vocabulary (Gates)	0.758**	0.639**	0.756**	0.161
34. Comprehension	0.736**	0.678**	0.697**	0.178
35. Slosson (sixth month)	0.720**	0.568**	0.831**	0.315**
36. Word accuracy (Neale)		0.886**	0.638**	0.126
37. Comprehension			0.519**	0.010
38. Slosson (third month)				0.377**
39. Reading Program				-

** p < .01
 * p < .05